ESTIMATING THE NUMBER OF CENTENARIANS AND THE OLDEST-OLD IN THAILAND: TRENDS IN OLD AGE LONGEVITY FROM 1960 TO 2010

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ESTIMATING THE NUMBER OF CENTENARIANS AND THE OLDEST-OLD IN THAILAND: TRENDS IN OLD AGE LONGEVITY FROM 1960 TO 2010

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ABSTRACT

The objectives of this study were to estimate the number of centenarians and the quality of centenarian data in civil registration in Thailand. Data from several sources, namely the series of population census, the Survey of Population Change (SPC), the Coale and Demeny regional model life tables, and United Nations World Population Prospects (UN WPP) were used. The data from censuses were employed to calculate survival ratios among the oldest old. These survival ratios were then applied to appropriate model life tables. The data on centenarians as reported in the civil registration from two sample provinces were collected to support and qualitatively explain the prior quantitative findings.

These demographic procedures yielded an estimate of about 1,700 surviving centenarians in 2010, which was only 12% of the number recorded in official civil registration figures. The inflated estimates of the centenarian population recorded by the civil registration system were investigated by in-depth interviews of centenarians, village/sub-district headmen, registrars, and relatives of deceased persons in the two selected provinces. Names and addresses of centenarians were acquired from civil registration and were followed up to evaluate their accuracy. Among 429 recorded centenarians, only 43 cases (10%) were found to be true centenarians. Among the remaining 90% of recorded centenarians, most had already died and some were found to have ages of less than 100 years. The ages of all recorded centenarians over 106 years were found to be incorrectly recorded and were over reported in all cases. It was also found that incompleteness of death registration and incorrect age recording were the main causes of the inflated figures of centenarians found in registration data in Thailand.

KEY WORDS: ELDERLY/ CENTENARIAN/ SURVIVAL RATIO/ INCOMPLETENESS OF CIVIL REGISTRATION/ THAILAND

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การคาดประมาณจำนวนศตวรรษิกชนและผู้สูงอายุวัยปลายในประเทศไทย: แนวโน้มความยืนยาวของชีวิตเมื่อสูงวัย จาก 2503 ถึง 2553

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บทคัดย่อ

การศึกษานี้มีวัตถุประสงค์เพื่อทำการคาดประมาณจำนวนศตวรรษิกชน หรือคนที่มีอายุหนึ่งร้อยปีขึ้นไป และศึกษาความสมบูรณ์ของข้อมูลคนร้อยปีในทะเบียนราษฎร ประเทศไทย ข้อมูลที่ศึกษานำมาจากหลายแหล่งข้อมูลด้วยกัน เช่น ชุดข้อมูลจากสำมะโนประชากร , การสำรวจการเปลี่ยนแปลงประชากร , ตารางชีพแบบภูมิภาคของโคล และดีเมน และ ข้อมูลทางประชากรของสหประชาชาติ ข้อมูลจากสำมะโนประชากรยังถูกนำมาใช้เพื่อคำนวณหาอัตราการรอดชีพระหว่างผู้สูงอายุตอนปลาย และอัตราการรอดชีพดังกล่าวได้ถูกนำมาปรับเพื่อให้ได้มาซึ่งตารางชีพที่เหมาะสม นอกจากนี้ยังมีการศึกษาข้อมูลเชิงคุณภาพโดยการเก็บข้อมูลจากการรายงานจำนวนศตวรรษิกชนของทะเบียนราษฎรจากสองจังหวัดตัวอย่าง เพื่อสนับสนุนผลการศึกษาในเชิงปริมาณ

ผลจากการคาดประมาณพบว่า มีจำนวนศตวรรษิกชนประมาณ 1,700 คน ใน พ.ศ. 2553 ซึ่งคิดเป็นร้อยละ 12 ของจำนวนศตวรรษิกชนทั้งหมดที่ถูกบันทึกไว้ตามหลักฐานทะเบียนราษฎร จากจำนวนศตวรรษิกชนที่มากเกินความเป็นจริงตามหลักฐานทะเบียนราษฎรถูกทำการตรวจสอบโดยการสัมภาษณ์ระดับลึกกับคนที่มีอายุหนึ่งร้อยปีขึ้นไป , สัมภาษณ์กำนัน , ผู้ใหญ่บ้าน , นายทะเบียน และญาติ พี่น้องของศตวรรษิกชนในสองจังหวัดตัวอย่าง โดยได้ติดตามเพื่อประเมินความถูกต้องของ ข้อมูลศตวรรษิกชนจากชื่อและที่อยู่ที่ได้รับจากทะเบียนราษฎร ผลการศึกษาในเชิงคุณภาพพบว่า จากจำนวน ศตวรรษิกชนตามหลักฐานทะเบียนราษฎ รจำนวน 429 ราย มีเพียง 43 รายเท่านั้น หรือเพียงร้อยละ 10 ของจำนวนศตวรรษิกชนที่ปรากฏในทะเบียนมีอายุมากกว่าหนึ่งร้อยปีขึ้นไป อีกร้อยละ 90 พบว่าได้เสียชีวิตไปแล้ว และบางรายมีอายุน้อยกว่า 100 ปี อายุของบุคคลที่สูงกว่า 106 ปี ตามทะเบียนราษฎร พบว่ามีความไม่ถูกต้องในการบันทึกข้อมูล และมีก ารรายงานอายุ เกินความเป็นจริง นอกจากนี้ยังพบว่า ความไม่สมบูรณ์ในการจดทะเบียนตาย และการรายงานอายุผิดพลาด เป็นปัจจัยสำคัญในการทำให้จำนวนศตวรรษิกชนไทยในทะเบียนราษฎรสูงเกินความเป็นจริง

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CHAPTER I
INTRODUCTION

This chapter presents the rationale and statement of the problem. This chapter also discusses research questions and objectives of the study. Finally, it presents the expected outcomes.

1.1 Rationale and statement of the problem

The population of Thailand has been aging rapidly over the last half century due to declines in fertility, and mortality. The total fertility rate of Thai women has decreased from over 6 children born per woman in the 50 years ago to 1.5 per woman in 2011. Meanwhile, the life expectancy at birth has increased from less than 50 years in the 1960s to 74 years in 2011(Prasartkul & Vapattanawong, 2011). These changes in fertility and mortality have led to major shifts in the age structure of Thailand's population with significant increases in the number and proportion of the elderly population. According to the 1960 census, there were about 1.2 million people aged 60 years and over (National Statistical Office, 1962), which accounted for 4.7 percent of the total population of 26 million of Thailand. The number of people aged 60 and over in the Thailand reached 8.5 million in 2010, which was 13 percent of the total population of 65.9 million (National Statistical Office, 2011). In addition, the oldest population (80 years old and over) has almost doubled over the past 50 years, from 0.7 million in 1960 to 1.1 million in 2010 (National Statistical Office, 1962; National Statistical Office, 2011). The oldest old population, i.e. centenarians or people aged over 100 years, is an exceptional group, since the number or proportion of centenarians is likely to increase according to extended longevity of the population. The United Nations estimated that there were 292,000 centenarians worldwide in 2010, and the number would reach 906,900 in 2025 (United Nations, 2010). The number of Thai centenarians is still in question, however.

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As a result of becoming an aged society in Thailand, many researchers turn their interest to the elderly topics, concerning mostly to their lifestyle, security, well-being and health. The technological and health development seems to insure that people can live much longer. The life of more than 100 years old or being a centenarian seems to be not far beyond reach among oldest old nowadays. The number of centenarians reflects the longevity of the population. Thus, the proportion of centenarians can be used as an indicator of people's longevity of a country.

The life expectancy and life span are indicators to measure longevity of human. Life span refers to the maximum age of human life (INED, 2011). Until the recent decade, people can live longer because the effect of the achievement of modernization that reduces in human mortality. At present, the world's oldest living person in the world is Besse Berry Cooper of American, who is 115 years old in 2012. However, it has also revealed that the longest documented life span is Jeanne Calment at the age of 122.45 years (Guinness World Records Corporate, 2012).

There are many research studies conducted in centenarians issue, such as Georgia Centenarian Study (1988-2007); Harvard Health Medical School (2002); The New England Centenarian Study (2002); Max Planck Institute for Demographic Research in Germany (2009); The Okinawa Center Study in Japan (2008); Images of Ohio Centenarians in Miami (2009) etc. Most of these studies focus on the emergence of centenarians and emphasize estimation of the number, and the trend of number of centenarians. Some studies investigated how centenarians live longer. Besides, some are interested in the factors affecting human longevity such as biological factors that include genes and family longevity, and also the environmental factors that contribute to human longevity as well.

In Thailand, some centenarian clubs are being established. For example Shek Thanasiri's "U-Roi-Pee Cheeve Mee Suk Club" aiming to campaign for longer lives with good health established by Balavi Natural Health institution (Balavi Natural Health Center, 2004). Mahidol University has been conducting a competition event on healthy centenarian mothers as an activity to celebrate Mother's Day in August since 2005. The Institute for Population and Social Research has established the Thai Centenarians Center to collect data and information relating to those oldest elderly in Thailand, especially centenarian people (IPSR, 2010).

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In some countries, centenarians are received expression of appreciation and recognition by the government. For example, in the United States, there is a tradition that the president sends a letter to citizens on their 100th birthday. In the United Kingdom, the Queen sends greeting as telegram on their 100th birthday and on every birthday starting from the 105th. In Japan centenarians receive silver cups and certificates from the Prime Minister upon their 100th birthday. Similarly, In Sweden centenarians receive a telegram from the King and Queen of Sweden. In Italy, centenarians receive a letter from the President of Italy (Gerontology Research Group, 2011). However, we have never seen these centenarian campaigns from the government in many countries.

Civil registration is one of the main sources of population data in Thailand and includes birth and death records. Although it might be expected that the quality of the civil registration system has improved over time, several recent studies have found continuing incompleteness of death registration and have recommend improvements to the system (Hill et al., 2007; Prasartkul & Vapattanawong, 2006; Preston & Hill, 1980; Rukumnuaykit, 2006; Tangcharoensathien et al., 2006; Vapattanawong & Prasartkul, 2011). When death registration figures are incomplete, estimates of the number of surviving centenarians is likely to be inflated. The aim of this study is to provide a more accurate estimate of the population aged 100 years and over, and to assess the quality of registration data on centenarians.

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1.2 Research questions

1.2.1 How many centenarians are in 2010 in Thailand?

1.2.2 What are the survival patterns among the oldest old in Thailand?

1.2.3 How is the quality of centenarian data in civil registration of Thailand?

1.3 Objectives

This study has three objectives:

1.3.1 To estimate the number of centenarians in Thailand

1.3.2 To study the survival patterns among centenarians and oldest old in Thailand

1.3.3 To assess the quality of data on centenarians in Thailand.

1.4 Expected outcomes

Since there are very few researches studying in this topic in the country, this study will be an exploratory and pioneering in this field. This study will fill the gap in knowledge on this important issue. Furthermore, the findings of this study will be useful for the civil registration to improve the incompleteness of data recording. Besides, the improvement of registration system will certainly benefit to the government and the Thai people. Moreover, this study may also be useful for the policy makers and program planners to advocate on the issues related to centenarians and their quality of life.

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CHAPTER II
LITERATURE REVIEWS

This chapter reviews selected literatures relevant to the centenarians is presented. It describes term of older persons, situation of elderly, and longevity. It also presents the emergence of centenarians, and mortality at oldest old.

2.1 Term of older persons

The terms of elderly or older person are different in each country. It depends on the culture, social, economic factors of those countries, and also the level of population ageing (Stloukal, 2004). Most developed countries have accepted the age of 65 years as a definition of elderly or older person(United Nations, 2006). However, people aged 60 years and over in Thailand are defined as the older person and retirement age. Moreover, the beginning of old age in some countries is associated with the aged of retirement.

The groups of elder people are classified by 3 groups as follows (IPSR, 2004):

1. Young old refers to people who are aged 60 to 69 years.
2. Medium old refers to people who are aged 70 to 79 years.
3. Oldest old refers to people who are aged 80 years old and over.

2.2 Situation of elderly

The United Nations defined that any countries where has population aged 60 years and over, more than 10 percent and/ or has population aged 65 years and over more than 7 percent of whole country are called the “aging society” (United Nations, 2010). Moreover, UN is assembly designated as 1 October to be the international Day of Older Persons of the world (United Nations, 2011).

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The number of persons age 60 years and over were 204 million or 8 percent of 2.5 billion of the world in 1950. At that time, there were only 3 countries which had more than 10 million older persons; China (42 million), India (20 million), and the United States of America (20 million). In the next 50 years, the number of elder persons has triply increased to 609 million in 2000 indicated that substantial proportion (10%) of world population were elderly. In 2010, the older population has been rapidly increasing in all countries. The number of old population had increased to 759 million or 11% of 6,895 million world population. It is projected that the number of elder persons worldwide will be increased more than three times and will reach nearly 2 billion or 21% in 2050. It means that one elderly will be out of every five person in the world (United Nations, 2002). When considering between the regions, the proportion of elderly was very high in developed regions than less developed regions. For instance, in 1950, the percentage of older persons were about 12 percent in developed regions while it was only about 6 percent in less developed regions. The percentage of elder person has increased over time and reached about 34 percent of most developed regions and about 18 percent of less developed regions.

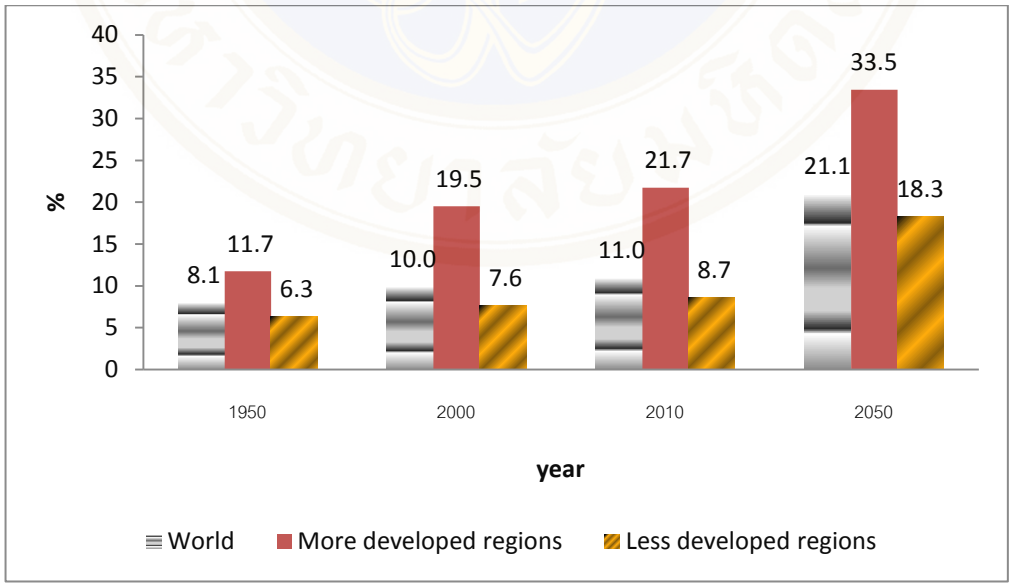

Figure 2.1: The percentage of older persons aged 60 years old and over by regions

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It is also found that Thailand has begun the transition to an aging society. Phenomena of population aging in Thailand can be seen from the rapid increase of population of elderly aged 60 years and over and 80 years and over in Table 2.1. It is showed that the number and percentage of both elderly age groups during 1960-2000 has been increased slightly. For example, the number of elderly aged 60 years and over has increased from 4.7 percent in 1960 to 13.0 percent in 2010. It will be reached 26.9 percent in 2040. At the same time, the number of elderly aged 80 years old and over has increased slightly from 0.5 percent in 1960 to 1.7 percent in 2010 and it will reach 3.8 percent in the next 30 years. Due to the increase number of aging population and increasing life expectancy rate, it can be assumed that the number of centenarians is likely to be increasing in Thailand.

Table 2.1: The total number of population, population aged 60 years and over, and population aged 80 years and over

Years	Total population per 1,000	Population aged 60 years and over		Population aged 80 years and over	
		Number (per 1,000)	percent	Number (per 1,000)	percent
1960	26,269	1,230	4.7	127	0.5
1970	34,397	1,681	4.9	138	0.4
1980	44,824	2,445	5.5	226	0.5
1990	54,548	4,016	7.4	442	0.8
2000	60,916	5,793	9.5	586	1.0
2010	65,926	8,566	13.0	1,093	1.7
2020	65,138	10,954	16.8	1,193	1.8
2030	64,519	14,641	22.7	1,551	2.4
2040	61,721	16,600	26.9	2,372	3.8

Sources: 1960, 1970, 1980, 1990, 2000, 2010: calculated from Censuses
2020, 2030, 2040: projection from Institute for Population and Social Research, 2007.

In table 2.1, it is shown that the total population of Thailand has increased rapidly from 26 million in 1960 to 65 million in 2010. The population of 2010 recorded highest, after this period, the population of Thailand was projected deceasing.

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It is notable that the estimated number of population in 2040 will be almost similar as the population of 2000. Besides, the proportion of elderly population has increased rapidly during this time. At the same time, the number of children aged less than 15 years old will be slightly decreased and the number of adult people will be constant around 40-43 million and shapely at 36.6 million (table 2.2). On the other hand, the number of elder people will increase dramatically during these times. It indicates that the older population is growing faster than the total population. It is also estimated that the number of Thai elderly people will be almost double than the number of children in 2040.

Table 2.2: The projected number of population by age group, 2010, 2020, 2030, 2040

Age group	2010	2020	2030	2040
0-14	13,202,899	11,172,238	9,770,191	8,493,257
15-59	42,926,583	43,011,884	40,107,908	36,627,562
60 +	7,522,840	10,954,191	14,640,652	16,600,432
Total	**63,652,322**	**65,138,313**	**64,518,751**	**61,721,251**

Source: calculated from Institute for Population and Social Research, 2007.

In addition, the median age, the age that divides the population in two parts of equal size, is another indicator pointing out that Thailand is becoming to aging society. The median age of Thai population has been increasing from 18 years in 1960 to 34 years in 2011 (half of population is 34 years old and over, while the other half are younger) (IPSR, 2011). It means that the age structure turns aging.

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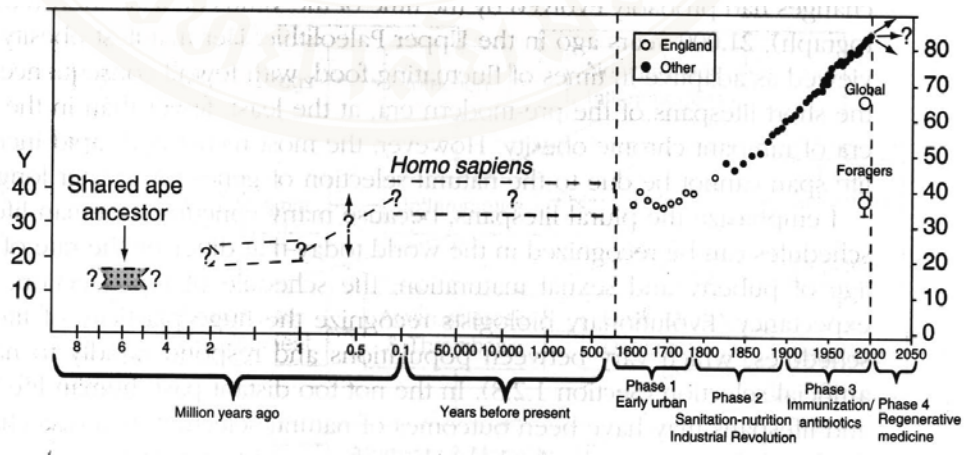
2.3 Longevity

Longevity is the length or duration of a person's life. The measurement of longevity should be distinguished by two concepts: life span and life expectancy (Siegel et al., 2004).

Most of people are interested about how long individuals can live or what is the maximum life span of human. Naturally, nobody is immortal and nobody knows the length of one's own life. However, in reality, everyone would like to live longest without diseases. But the longevity of each person is different.

Human longevity has evolved in three major stages (Finch, 2008). The first is ancestral ape, 5 million years ago or more. During this period the life expectancy was about 13 years while life span was about 40 years. In the second stages was called Homo sapiens that the life expectancy doubled from the 20 years of ape-human to about 40 years. The life span in the stage was also increased dramatically to 80 years. The last stage occurred since the 18th century, during the industrial revolution. The life expectancy has doubled again to 80 years through the development of technology, public health, economic, nutrition and water because of the influence on reduction of mortality and fertility after World War II. Life span of human also has sharply increased to 122 years as shown in figure 2.2.

Figure 2.2: The evolution of human life expectancy



Source: Fince, E. C. 2007.

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As mentioned above, the human longevity has always been related with the length of life. It can be seen from the increasing of life span and life expectancy.

2.3.1 Life span

Life span is an indicator of longevity measurement. It refers to the extreme limit set to human life by old age (Dublin & Lotka, 1949). INED (2011) denotes the life span as the maximum age that human beings could reach under optimum conditions. Besides, the life span is the age limits of human life that can reach under optimum conditions (Siegel, et al., 2004). Life span is different from life expectancy, which is the average number of years a person can expect to live. The year of life expectancy can be equal to life span through healthier living, and the prevention of chronic illnesses.

In the past, the life span was very short lives about 40 years because of the high mortality. Maximum human life span has been extended to 115 years and trend to increase more. The highest human life span in the world is Jeanne Calment who lived the longest and died in 1997 at the age of 123 years according to the records of The Guinness Book. At present, the oldest living person in the world is Besse Berry Cooper, an American supercentenarian, who is oldest people at age 115 years in 2011 (Gerontology Research Group, 2011; Guinness World Records Corporate, 2012). However, the maximum human life span each country is still in the question especially Thailand. Centenarians or people aged 100 years and over are only a very small group. This elderly group represents a special segment of the population who can live longer than the average life expectancy. The definition of centenarians is the survivors who have lived to at least 100 and attained to the age of 100 year or more (The University of Georgia, 2005). It is notable that the highest life span human can live longer than life expectancy in the present.

2.3.2 Life expectancy

Life expectancy is another significant indicator of longevity. It is a measure of mortality that is independent of the effects of age structure. Life expectancy refers the average number of years a person can expect to live (World Health Organization, 2012). United Nations (2010) defines the life expectancy at birth

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as an estimate of the number of years to be lived by a female or male newborn, based on current age-specific mortality rates. INED (2011) also defines as an average number of years a group of individuals can expect to live. Similarly, Siegel and Swanson (2004) explain the life expectancy as the average expected number of years to be lived.

The life expectancy must be derived from a life table constructed from age specific mortality schedules. Life table is an important measurement which achieves to measure life expectancy. Life expectancy at birth (e_x) is a well-known summary measure of mortality (Rowland, 2006). It refers to average number of years a person could expect to live after birth (IPSR, 2011).

World record life expectancy has risen linearly from 25 years in the past million years ago to about 68 years for men, and 73 years for women at present (United Nations, 2010). African countries have the lowest life expectancy at birth, about 58 years of both sexes. The life expectancy of developed countries with low mortality rates such as Europe, America, and some Asian countries, is higher and still increasing exceeds 80 years namely Canada, France, Sweden, Switzerland, New Zealand, Italy, America, Japan, Singapore, Australia etc. (Population Reference Bureau, 2011). However, the life expectancies have been rising in countries where economic and health improvements more recent, such as China, India, and the countries of South America.

The life expectancy in Thailand has dramatically risen from about 40 years in 100 years ago to 73 years in 2011 (69.5 years for males, and 76.3 years for females) (IPSR, 2011). At the same time, the life expectancy at age 60, the average number of years a person could expect to live after age sixty, has increased from 12 years in 100 years ago to 21 years (19 years in males, and 22 years in females) in 2011 (IPSR, 2011). In the next 30 years, we expect that the life expectancy at birth and at age 60 of Thailand will be increased to 82 years and 25 years respectively, as same as the life expectancy of Japan in 2010 (Table 2.3).

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Table 2.3: The trend of the life expectancy at birth, at age 55 years, 60 years, and 65 years

Life expectancy (e_x)	**100 years ago**	**50 years ago**	**Present (2011)**	**Next 30 years later**
At birth (e_0)	37.3	58.4	72.9	82.0
At age 55 years (e_{55})	15.1	20.6	24.5	29.1
At age 60 years (e_{60})	12.3	16.9	20.7	24.5
At age 65 years (e_{65})	9.8	13.5	17.1	20.2

Source: Prasartkul and Vapattanawong, 2005

Calculated by borrowing the life expectancy from the West model life table based on life expectancy of Japan

In summary, human longevity has always been related with the length of life. It can be seen from increasing in life expectancy and life span. Thus, the longevity of population is receiving more attention due to population becomes more aging. However, there is no directly recorded who has the highest life span in Thailand because of the error on the age of extreme old. Thus, the studies on elderly especially oldest person or centenarian should realize about the completeness of data.

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2.4. The emergence of centenarians

The number of world centenarians has been rapidly increasing due to people becoming older. The United Nations estimated that there were 292,000 centenarians worldwide in 2010, and the number would reach 906,900 in 2025 (United Nations, 2010). In United States, the number of centenarian has been increasing from 37,306 persons in 1990 (Daley et al., 1990) to 53,364 in 2010 (Werne, 2010). The number of centenarians in Japan has reached 10,158 in 1998 and has risen more than 47,000 in 2011(The Hindu, 2011). According to Japan has the completeness of registration because of a national registration law was enacted at the beginning in the Meiji Era (Robine & Saito, 2003). Thus, we can assume that the number of Japanese centenarians is quite perfect. The trend of centenarians in England and Wales also increased from nearly 6,000 in 1996 to almost 20,000 in 2010 (Thatcher, 2001). These numbers of centenarians in every country are expected to rise substantially in the next several decades. The number of Thai centenarians is still in question, however.

In Thailand, there are many sources of data that are shown estimated number of Thai centenarians such as the civil registration, census, and projection by Institute for Population and Social Research. However, the number of Thai centenarians in every source is much different. According to the civil registration of the Ministry of Interior (MOI), there are 14,493 centenarians in 2010. Among these centenarians, 6,019 are males, and 8,474 are females (Department of Provincial Administration, 2011). According to the Survey of Population Change in 2005-2006, the estimated numbers of centenarians are 8,000; 2,800 males, and 5,300 females, which is much less than the MOI figures, (National Statistical Office, 2008). Institute for Population and Social Research (2008) estimated the number of centenarians in 2010 at about 1,600 centenarians; 800 males, and 800 females. If compare the total estimated number of centenarians among different sources, it seems that the number of centenarian recorded in civil registration is very high, may be exaggerated (Table 2.4). The incompleteness of registration data may lead to over or under recorded Thai centenarians.

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Table 2.4: Number of centenarians in Thailand by sources of data

Sources	Male	Female	Total
Civil Registration (2010)	6,019	8,474	14,493
SPC (2005-2006)	2,800	5,300	8,100
IPSR (2009)	1,000	1,200	2,200

Source: Ministry of Interior, 2008
Civil Registration, 2010
The Survey of Population Change (SPC), 2005-2006
Institute for Population and Social Research, 2009

Thus, it can be assumed that the centenarian's data is found some weakness and invalid points. No evidence indicates the maximum life span and the exact number of centenarians in Thailand. However, the indirect methods can be used for estimating the number of centenarians such as the study in the United States and in Brazil (Gomes & Turra, 2009; Siegel & Passel, 1976).

The number of centenarians tends to increase in the future. It is due to the steady decline of mortality in the oldest-old in recent decades (Andersen-Ranberg et al., 2001). Healthy longevity is an important issue for individuals. Everyone expects to have longer active lives and free from disability. There are several studies interested in the topic of wellbeing and health. However, few studies have investigated measurement of health status of the centenarians. Some studies showed that centenarians markedly delay disability towards the end of their long lives namely in functional decline and age-related lethal diseases; heart disease, cancer and stroke. Centenarians are also identified as three types, survivors, delayers, and escapers (Evert et al., 2003; Hitt et al., 1999). A study found that male centenarians have low disability than female centenarians (Franceschi et al., 2000).

There are many studies related in perceived health of elder people. Studies show that many older people had a positive perception of their health (Burke et al., 2001; Chan et al., 1998). For example, Bryant and others (2002) found that older people perceived healthy aging in terms of *going and doing something meaningful,* which comprised 4 components: something worthwhile and desirable to do, balance

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between abilities and challenges, appropriate external resources, and personal attitudinal characteristics (Bryant et al., 2002). A study conducted in Thailand found that self-perceived health status of elderly men in all age group has been improved over time. However, those of elderly women did not show the same pattern (Rakchananyaban, 2004). In contrast to this, some study found that oldest old people were more likely to report poor health than young old (Haseen et al., 2010).

A study found that most centenarians seem to be frail however there are a small number of centenarian individuals with excellent physical and cognitive functions (Gondo et al., 2006). On the other hand, the other study conducted in Japan found that almost all centenarians (95%) had chronic disease. It is also found that the level of physical and cognitive function in men were higher than in women (Takayama et al., 2007).

A study conducted among Danish centenarians found that 20% of women, and 44% of men were able to perform all selected activities of daily living (ADLs) independently (Andersen-Ranberg, et al., 2001). A chronological study conducted in Okinawan centenarians in Japan found that centenarians activities of daily living have declined markedly during the 20 years period from 1970s to the 1990s (Suzuki et al., 1995). Among the Egyptian elderly, nearly 9% of the elderly reported having difficulty in performing one or more ADLs (Nandakumar et al., 1998). Besides, the proportion of those with ADL limitations increasing significantly with age (Nandakumar, et al., 1998; Rakchananyaban, 2004)

Moreover, most national surveys of elderly person including the survey of older Person in Thailand measure the ability of elderly people to perform the ADLs. The survey of older person in Thailand found that more than 90 percent of all older people can perform at least one activities by themselves (NSO, 2008). However, some studies also found that elderly women had higher prevalence rate of ADLs disabilities than elderly men. It is due to males with ADLs limitations are more likely to have a spouse to look after them whereas females with ADLs problem would have to depend on other relatives to provide assistance (Nandakumar, et al., 1998).

In summary, many studies showed that centenarians represent a select group and a resource for the study of successful aging and associated with achieving

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longevity (Buono, et al., 1998; Perls et al., 1999). Most centenarians are still healthy and independent for most of their live (Hitt, et al., 1999).

2.5 Mortality at oldest old

In demography, mortality is one of the components of population change. Mortality affects to the growth rate of population and changes in age-sex structure. It is described by the demographic transition theory. The demographic transition refers to the movement from high birth and death rates to low birth and death rates in a society originated from observations of long-ran changes in European countries (Rowland, 2006). It comprises three stages. In the pre-transition stage, population growth was low due to high mortality and fertility. High mortality was associated with famine as *"age of pestilence and famine"* in Omran's theory (1971). People in this stage had chance to get morbidity easily because of infectious diseases and low living standard and nutrition. Thus, an average life expectancy in this stage was under 30 years. In the second stage or *"age of receding pandemics"*, population growth was high due to mortality decline while fertility was still high. The mortality was dropped rapidly due to improvements in food supply and sanitation. It made the life expectancy has risen considerably from under 30 to 50. The last stage or the *"age of degenerative and man-made diseases"*, population growth has been reduced nearly equal to zero due to low mortality and fertility after World War II. Population can live longer due to the improvement of socio-economic, medical and public health, and living standard. Besides, the infant mortality rate has been reduced from over 100 per 1,000 persons to lower than 20 at present (IPSR, 2011). Thus, the data of mortality such as the number of deaths, age at death, the date of death, causes of death or the place at death are benefit to analyze the longevity of population.

When considering on the pattern of mortality, it should be started with the Gompertz law of mortality (1825). He described the age dynamics of human mortality in the age of about 20 to 60 years. The mortality of human population between age 20 and 60 will be exponential increased. However, some demographers found that human mortality did not increase exponentially after age 80. Mortality at more advanced ages will be slightly decelerated, slowly increased or slowly decreased because of

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CHAPTER III
RESEARCH METHODOLOGY

This chapter presents the methodology of study that uses both quantitative and qualitative research methods. The quantitative study shows many sources of data to calculate the probability of surviving among the oldest old, namely censuses, The Survey of Population Change, United Nations World Population Prospects (UNWPP), and Coale and Demeny model life table. The qualitative study uses the data from the civil registration. Besides, the measurements of this study also present. It comprises the survival ratio, Census Survival Ratio (CSR), life table survival ratio based on Thailand life table, the West model life table and United Nations World Population Prospects (UN WPP), level of mortality from life table used, and step in estimating the centenarians

3.1 Source of data

This study employs secondary data from several sources to calculate the probability of surviving among the oldest old. Those sources are as follows:

3.1.1 The Population and Housing Census 1960-2000

The National Statistical Office (NSO) undertakes a population and housing census in every ten years. Thailand has already been conducted the population census for 10 times. The census 2010 is the eleventh round, which is the 100th anniversary of Thai population census. Thailand's first population census was conducted in 1909 by the ministry of interior. The NSO has been responsible for undertaking population census since the sixth round. The objective of the census is to count the number of population

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and households in Thailand. Besides, the census aims to gather the information about demography, economic and social characteristics of population, and housing in Thailand.

The following information is covered by the census in 2000 (National Statistical Office, 2002):

1. All Thai nationals residing in the country as of the census date.
2. Persons having their usual residence in Thailand, but as of the census date, are away temporarily at field exercises, at sea or temporarily abroad.
3. Government officials, both civilian and military including Thai diplomatic personnel, and their families stationed abroad.
4. Civilian nationals of foreign nations having their usual residence in Thailand of those who had resided in Thailand for at least three months as of the census date (before January 1, 2000).
5. The housing census includes all private households.

This study uses Thai censuses data from 1960 to 2000. The report 1960 census is used while the micro data from the 1970-2000 censuses are limited to people who were born in Thailand. The assumption of a closed population with zero international migration between censuses is necessary to estimate inter-censual survival ratios.

The objective of using census data is to estimate the probability of surviving based on census survival ratio method. The number of census population during the period 1960-2000 is required at two points in time. Furthermore, the initial census population also is used for multiplying by the survival ratios to get the estimated number of centenarians and oldest old.

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3.1.2 The Survey of Population Change (SPC)

The Survey of Population Change, or SPC, is an intercensal survey conducted at the national level every ten year. It is undertaken by National Statistical Office (NSO). Seven surveys, 1964-1966, 1974-1976, 1984-1986, 1989, 1991, 1995-1996 and 2005-2006, has been done and the 8th survey is currently being collecting. This survey aims to collect the information on birth, death, and the change in demographic characteristics which occur between each round covering the period of 3 months. A stratified multi-stage sampling technique was used in all surveys. However, the methodology used to estimate vital events of each SPC is different. The 1st to 3rd SPC used dual records procedure and Chandrasekaran-Deming formula while the others directly estimated total events from sample households only. This difference may affect to the quality and completeness of vital registration calculated from each method.

3.1.3 United Nations World Population Prospects (UN WPP)

United Nations World Population Prospects (UN WPP) is one of the primary sources of data which publish demographic information for each country around the world. This data can be found online. This study uses online data of the age structure and life expectancy at birth, and at age 60 years old and over from 1960-2010. The objective of using this source is to estimate the probability of surviving.

3.1.4 Coale and Demeny Model Life Table

The Coale and Demeny regional model life tables are applied for estimating mortality level (Siegel, et al., 2004). This model life table is very useful resource for countries where the mortality data are limited and incompleted. There are four sets of model life table; West, East, North and South (Coale & Demeny, 1966). Each set of model life table represents an individual mortality pattern as below.

1) East model: This model is based on Central European experience such as Austria, Germany, Czechoslovakia, North and Central Italy, Hungary, and Poland. The age mortality patterns from these models follow the expected U shape with high mortality rates in infancy and at older ages (over age 50).

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2) North model: This model comes from Iceland, Norway and Sweden. The characteristics of this model is low infant mortality with high child mortality and high mortality rates above age 50 that fall increasingly below those of the standard.

3) South model: This model is based on life table from Spain, Portugal, Italy, and the region of Sicily. The pattern of mortality is characterized by high mortality under age 5, low mortality from about age 40 to age 60 and high mortality over age 65.

4) West model: This model is based on the 125 life tables from over 20 countries, including Canada, The United States, Australia, New Zealand, South Africa, Israel, Japan, Taiwan and Western Europe. This model is wildly used for many countries due t it constructed from many life tables and based on many countries as well.

The Coale and Demeny regional model life tables have three editions. First it was published in 1966 which contained 24 mortality levels from age 0 to 85 years. The life expectancy at birth ranged from 20 years to 77.5 years. The second edition was published in 1983 (Coale & Demeny, 1983). It contains 25 mortality levels based on life expectancy at birth from 20 years to 80 years. The model life tables include all ages going up to 100 (Siegel, et al., 2004). In addition to this, the third model, which is the latest and new the model life table published in 1991 by Coale and Guo's. This model was revised by extending mortality to the lower levels. The new model life table extended to level 27, representing the e_0 of 85.0 years for females and 78.9 years for males. Moreover, this new model extended age groups from ending at 85 in the old model to 100 years of age in the new model. Therefore, the model life table in this study is based on the both second and third edition which published in 1983 and 1991 respectively.

As mentioned earlier, the West model life tables are used in this study. It is due to the West model is constructed from the largest number of life tables from many countries of European, America, Asia, Africa and Australia (Coale & Demeny, 1966). It is then assumed that they can represent the most general mortality patterns especially of those countries where little is known about the population under study. For this reason, the West model is often recommended to represent mortality in countries and more appropriate choice of model (United Nations, 1983). Furthermore,

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other models are constructed from a few counties and represents only specific areas. Thus, the West model life table can be a representative of the general mortality patterns in Thailand and also appropriate choice to estimate the number of centenarians and oldest old in Thailand.

The West model life table had been used in many studies (Coale, 1985; Coale & Ellen Eliason, 1986; Garson, 1991). Most of mortality studies in Thailand also used West model life table (Bundhamcharoen et al., 2011; Hill, et al., 2007; Prasartkul & Rakchanyaban, 2002; Vapattanawong et al., 2007). However, there were some studies which had used North model life table (Fulton, 1979; Hirschman et al., 1994; Luther & Dhanasakdi, 1986; Pejaranonda et al., 1983). Knodel and Chamratrithirong (1978) study which compared the estimation of infant and child mortality in Thailand based on the West and North model life tables, however, found that there was not much variation in the results from both models (Knodel & Chamratrithirong, 1978).

3.1.5 Civil Registration

The civil registration is one of the important sources of data on population. It records the vital events including three types of events namely birth, death, and migration (DOPA, 1999; Ministry of Interior, 1991). The birth and death registration was started in 1916. The civil registration is now undertaken by The Office of Registration Administration (ORA) under the Department of Provincial Administration (DOPA), Ministry of Interior. DOPA publishes the total number of population in Thailand at the end of each year, as of the 31st December, by provinces and the whole country. In the past the collection of information on civil registration was poorly documented and was not centralized. However, civil registration has been improved with computerized data processing, improved data verification, and increasing incompleteness during 1980s.

According to the act of civil registration in 2008, birth and death must be registered to an officer, within 15 days for the birth and 24 hours for the death (Ministry of Interior, 1991). The first step of the processes of death registration is that the house-owner or deceased's relatives or a person who found the dead body notifies the death at the registration office nearby the event occurs. If the death is not notified,

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the information about the death is lost. In the next step, the registrars who have responsibility about the death notification issue a “death certifying form”. The required documents to give to the registrar are including personal identification card of the person who notifies the death, the death notification letter (if available) and the copy of family registration that displays the name of the dead person and the list of the persons in the registration (if available). When the death is reported, the person who receives the letter must go to the district registration office to get the death certificate.

This study uses the centenarian information from primary data source based on the information of civil registration in 2010. The information is collected though fieldwork among centenarians in two sampled provinces of Thailand, Nakhon Pathom and Petchaburi. The names of people aged 100 years and over by sex, address, birth date and nationality in those two provinces are permitted to use from ORA. The objective to use this data is to explain the reasons for incorrectness of registration data, and the quality of centenarian data from Thai civil registration.

3.1.6 Data from the field work

Centenarians recorded in civil registration in two sample provinces are followed up to support and qualitatively explain the discrepancies from prior quantitative findings. Qualitative information can give detail and depth information about the issue. Since no difference of quality of civil registration among provinces in Thailand is assumed, two provinces in the central region namely Nakhon Pathom and Phetchaburi are selected for convenience.

Nakhon Pathom is one of the central provinces and located in perimeter areas. Phetchaburi province is also one of the central provinces and located in the west of Thailand. In Nakhon Pathom province, there are 101,087 elderly; 42,620 males, and 58,467 females aged 60 years in 2010. At the same time, there are 62,817 elderly; 26,848 males, and 35,969 females in Phetchaburi province (Ministry of Interior, 2010).

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Figure 3.1: Map of study sites

As mentioned earlier, the information of centenarians are permitted to use from ORA. These data are as of September 2010. The duration of fieldwork is from March to May 2011. Total number of centenarians recorded in these two sampled provinces in the civil registration is 429 (Nakhon Pathom 351; Phetchaburi 78). All centenarians in these two provinces are followed up by phone call, and visiting. In-depth interviews are also taken with village/sub-district headmen, registrars, and relatives of deceased person in these two provinces. Collected information included socio-demographic characteristics, surviving status, exact age, year of birth, and the reasons of errors that may occur. The following steps are applied to collect the data:

Step 1: All centenarians recorded in the registration data for Nakhon Pathom and Phetchaburi provinces are followed up.

Step 2: Phone calls were made to officials of the Sub-district Administration Organizations (S.A.O.), sub-district headmen, village headmen, or community leaders. The survival status and addresses of recorded centenarians are checked.

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Step 3: The centenarians who are still alive were contacted directly or through their relatives. Information about exact age and year of birth is collected. If the person reported an age different from that recorded in civil registration, the perceived reasons for the errors are investigated. Furthermore, the ages of each centenarian's first and last children as well as their age at marriage are collected to validate the ages recorded in the registration. In the cases of mismatched ages, the perceived reasons for inconsistencies are discussed during interviews.

The information about living arrangement, main caregiver and health status are also collected. Three measurements of health status of centenarians covered in the study includes perceived self rated health, functional limitation, and daily living activities.

3.2 Measurement

The exact number of oldest old or centenarians in Thailand nowadays is unknown because inaccuracies in the measurement of advanced ages. To estimate the accurate number of centenarians, indirect methods can be used. However, it depends on the assumption of the study and also the data required of each method. To measure the estimated probability of surviving and number of centenarians in Thailand, the survival ratio from several indirect methods are used in this study.

3.2.1 The survival ratio

The survival ratio is the proportion of population at age y at time x that survives to age y+n at time x+n as below.

$$\text{Survival ratio} = \frac{\text{Population age y+n at time x+n}}{\text{Population age y at time x}}$$

For example, the 10-year survival ratios for the 50-54 years old group surviving to age 60-64 would be calculated by dividing the 2000 at age 60-64 years by the 1990 at age 50-54 years.

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Most studies use survival ratios to estimate probability of mortality by two methodologies: the census survival ratio and life table survival ratio (Siegel, et al., 2004).

3.2.2 Census survival ratio (CSR)

Census survival ratio (CSR) is one of indirect technique based on the survivorship between two censuses. CSR method represents the ratio of the population in a given age group in one census to the population in the same cohort at the previous census (Siegel, et al., 2004). The accuracy of mortality estimated by this method depends on the completeness of enumeration in both censuses and the accuracy of age reporting. CSR should be used only for population in which migration is negligible (United Nations, 2002). National census data for native-born residents should be used to help control the influence of international migration. Thus, it is important to assess the input data carefully and attend in the assumption.

This procedure can be used for estimating the centenarian and oldest old survivors from one census to later census. The survival ratio is used for projecting that is defined as the ratio between the population at time x per population at time x+n. Survival means living from age x to age x+n. This rate expresses the probability of survival of a population group. The survival ratio can be either one year, five years, or ten years. It depends on which census is used or then the international migration has not affected. In particular, the census survival ratio of aged 100 years and over in 2000 can be calculated as the number of people age 100 years and over in 2000 divided by the number of people age 90 years old and over in 1990 (100+ in 2000/90+ in 1990) as below:

$$CSR_x = P^n_{x+n} / P^0_x$$

National census survival ratios are applicable in the measurement of internal migration. However, they are also used in measuring or evaluating the level of mortality and in constructing life table especially for countries lacking adequate vital statistics.

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To estimate probability of surviving based on census survival ratio, the step used are followed as below:

Step 1: Divide the five-year age group population from latest census by the previous census to get the survival ratios each age group.

Step 2: Compare all survival ratios from step 1 by the West model life table

Step 3: Interpolate the mortality level using West model life table to get appropriate mortality level

3.2.3 Life table survival ratio based on Thailand life table

Life tables are an important instrument for analyzing mortality. It can show the summary of the mortality experience and survival of a cohort of population. In general, we can use both complete and abridged life table to calculate survival ratios. There is 1-5 or 10 year survival rates to estimate mortality. This study uses abridged life table for five year age group and 10 years inter-censual interval to estimate mortality in Thailand. For example, a 10 year survival rates for 45 year olds surviving to age 55 years in the next 10 years. Life table can offer alternative to estimate mortality by calculating the survival ratio from the Thai life table. This indirect method is called *"life table survival ratio"*.

According to life table functions, survival ratios for age groups are computed from the values of number of persons alive at age x+n (L_{x+n}) divide by those at age x (L_x) from the life table (Siegel, et al., 2004). However, for the open-end intervals, the values of total number of person years at age x+n (T_{x+n}) divided by those at age x (T_x). T_x column of life table is used for calculating the survival ratios at the highest age group. To indicate the open ended intervals, the survival ratios are the sum of L_xS from the initial age group to terminal age group such as L_x of survival ratios from age 85 years and over divided by the sum of the L_x from age 85 years and over. Thus, the T_x column represents the L_x column of life table to calculate the open-ended intervals. For example the number of survivors at age 85 and over is divided by the number of survivors at age 75 and older ($T_{85}/T_{75)}$. The formulas of survival ratios for five year age interval and open-ended age can be computed as below:

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Survival for five year age interval

$$ {}_5S_x = {}_5L_{x+1} / {}_5L_x \quad \text{e.g. } {}_5S_{80} = L_{85} / L_{80} $$

Survival ratios for open-ended

$$ {}_\infty LTSR_x = T_{x+5} / T_x \quad \text{e.g.. } {}_\infty S_{100} = {}_\infty T_{100} / T_{90} $$

For estimating the probability of surviving, the forward-survival method based on life table is used. The survival ratios are shown the proportion surviving from the age x to age x+n. Estimated survivors are obtained by multiplying the cohort's initial number by their survival ratio. The result is the number of survivors in time x+n.

The Thai life tables for calculating survival ratios are derived from the Survey of Population Change of Thailand (SPC) during 1964-1966, 1975-1976, 1985-1986, 1995-1996, and 2005-2006 undertaken by National Statistics Office of Thailand. The life tables from the SPC surveys are constructed from age specific death rate by the number of death and the number of population in the survey. SPC Life table in 1964-1966 is used to calculate the survival ratio during 1960-1970 periods; SPC life table in 1975-1976 for survival ratios in 1970-1980; SPC life table in 1985-1986 for survival ratios in 1980-1990and SPC life table in 1995-1996 for survival ratios 1990-2000. To estimate the probability of surviving in 2000-2010, the SPC life tables in 2005-2006 Thailand life tables are used.

Based on calculating of this method, the steps used are followed as below:

Step 1: Divide the L_{x+n} by the L_x for five year age group or divide the T_{x+n} by the T_x for open end age.

Step 2: Compare all survival ratios from step 1 by the West model life table

Step 3: Interpolate the mortality level using West model life table to get appropriate mortality level

3.2.4 Life table survival ratios based on the West model life table

An alternative for estimating old age mortality would be to borrow the survival ratios from other countries or regional model life tables when accurate Thai

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mortality data are not available. The West model life table from Cole and Demeny (1983) and Cole and Guo (1991) are employed for estimating the probabilities of surviving as mentioned earlier. To pick the correct level of the West life table, the mortality data from SPC during 1964-1966, 1975-1976, 1985-1986, 1995-1996 and 2005-2006 undertaken by National Statistics Office of Thailand are used to calculate the life expectancy in life table. This study uses both life expectancies at age 60 (e_{60}) for old age and life expectancies at age 15 (e_{15}) for younger age to imply with the level of mortality of West model. Those are chosen by assuming that the life expectancy at this old age is unaffected by mortality at younger ages especially during the infancy and childhood. An appropriate level of mortality can be located by the process of interpolation when the e_{60} does not match exactly with the level of life expectancy from model life tables. When the suitable level of mortality is obtained, the next procedure is calculation the survival ratios multiplying by the number of census population.

To estimate the probability of surviving based on life table survival ratio from the West model, the step used are followed as below:

Step 1: Bring the e_{60} for old age and e_{15} for younger age from SPC to pick the level of mortality

Step 2: e_{60} and e_{15} from SPC life table are applied at corresponding level of mortality of the West model life table.

Step 3: Assemble 20, 30 and 40 year cohort survival values by taking 10 year survival values from period life tables for each decade

Step 4: Interpolate the mortality level using West model life table to get appropriate mortality level

Step 5: Multiplying the cohort life table values by the census populations from 1960 to 1990

3.2.5 Life table survival ratios based on United Nations World Population Prospects (UN WPP)

The data from UN WPP are another tool of mortality estimation. UNWPP presents data for many countries around the world on standard measures, such as population size, total fertility rate, infant mortality rate, mortality rate, birth rate and

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so on. This method uses the population of Thailand and the life expectancy at age 60 estimated by the UNWPP to estimate survival ratios.

For calculating survival ratios based on United Nations, the UNWPP e_{15} for younger age and e_{60} for old age each interval between the periods 1960-2010 are used. These life tables are derived from age-specific death rates obtained from SPC. The mortality level implied by the West model life table of Coale and Demeny and Coale and Guo are borrowed to estimate survival ratios as the method of life table survival ratios. The steps for estimating mortality are similar with LTSR method as below:

Step 1: Bring the e_{60} for old age and e_{15} for younger age from UNWPP to pick the level of mortality

Step 2: e_{60} and e_{15} from UNWPP life table are applied at corresponding level of mortality of the West model life table.

Step 3: Interpolate the mortality level using West model life table to get appropriate mortality level

Step 4: Multiplying the cohort life table values by the UNWPP estimating populations from 1960 to 2000

3.2.6 Level of mortality from life table used

The measurement of mortality level could be performed from many indices. Usually, the information on death rates is computed from the censuses and civil registration system. Furthermore, the measurement of mortality levels is estimated from demographic indices such as crude death rates, age-specific death rates, and infant mortality rate. However, the life table which most common use for measuring the level of mortality also provide important information. It has the advantage of providing measurement of mortality that automatically is constructed in cohort form. The life expectancy at birth is one of the indexes of the level of mortality in life table. It can summarize of the whole series of mortality. In case of measurement the level of mortality at older ages, the expectation of life at aged 60 or 65 is used. Besides, the probability of surviving from life table is used to measure the mortality as well.

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Besides, the model life table can be used to evaluate the quality of the mortality data for underdeveloped populations (Siegel, et al., 2004). It is due to the mortality data of these countries is still incomplete. Use of these models becomes important when the available data are limited or defective. Model life tables are useful in demographic estimation for the less developed areas.

Thus, there are many methods which can use for studying the pattern of mortality. The life table can be borrowed from other countries where has similar the mortality experience. Besides, to bring the mortality rate from model life table can be used for measuring the level of mortality as well. The Coale and Demeny model life table are well-known and widely used measure of the level of mortality. Thus, this study uses this model life table to study the level of mortality.

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CHAPTER IV
ESTIMATES OF CENTENARIANS AND OLDEST OLD

The aim of this chapter is to evaluate potential sources of data in Thailand including series of Thai censuses and published model life tables. Based on Thai censuses, the Thai population in 1960, 1970, 1980, 1990 and 2000 is applied. Besides, the model life tables are used to evaluate the three sources of data. The first source is the Thai life tables. It derives from the Survey of Population Change of Thailand (SPC) during 1964-1966, 1975-1976, 1985-1986, 1995-1996 and 2005-2006 undertaken by the National Statistics Office of Thailand. The second source is the Cole-Demeny model West life table (Coale & Demeny, 1983) and a new regional model life tables of Coale and Guo at very low mortality in population for highest age group (Coale & Guo, 1989). The last source is based on the United Nations World Population Prospects (UNWPP) from 1960-2010 produced by the Population Division of the United Nations (United Nations, 2010).

The purpose to use several sources of data is to estimate the survival pattern based on survival ratio methods. The appropriate method is selected to estimate the number of centenarians and oldest old in Thailand.

In evaluation of data from various sources, this chapter is presented in three sections. First section is census evaluation. This step is the starting point for preparing to estimate survival pattern based on census survival ratios and trend in age structure and demographic information are also shown. Secord is to estimate survival patterns based on census survival ratio and life table survival ratio. It is also discussed in four sections; 1) Mortality estimates based on census survival ratios 2) Estimates of mortality from Thailand life table 3) Estimates mortality based on the West model life table, and 4) Estimates of mortality based on the United Nations World Population Prospects. The last section is to present the new estimates of centenarians and oldest old in Thailand based on the West model life table. It is presented in three sections; 1)

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The analysis of probabilities of surviving 2) The improved survival among Thai elderly, and 3) Estimated number of centenarians and oldest old in Thailand.

4.1 Census evaluation

An examination of the accuracy of the age-sex composition was the starting point for preparing to estimate number of centenarians, and the oldest old in Thailand based on census survival ratios. The 1960 census report and the raw censuses data of year 1970, 1980, 1990 and 2000 were the sources of data. One of the necessary assumptions of estimating inter-censal of survival rates is that there is no international migration between censuses. Therefore, the populations in the censuses from 1970 to 2000 were limited to people who are born in Thailand. Thus, our estimation of the survivors between the two periods was not included immigrants who had entered the country between censuses.

Some studies showed marked under-enumeration in each census especially the 1960 census in which age misreporting was prevalent. However, this study had to use the 1960 census to get the survival ratios among the old age in 1970 and onward.

Trends in age structure of censuses population Thailand

The accuracy of the censuses in Thailand from 1960 to 2000 could be indicated by patterns of age and sex structure in Thailand. According to the table 4.1, the numbers of population for both sexes tended to increase over time. The number of males and females and the age pattern in every year were quite similar. When eliminating people not native born in Thailand, the number of population in 1960-2000 had continuously increased for both males and females. In the 1960, the number of population was about 26.3 million, among which males were 13.2 million and females were 13.1 million. After four decades, the number of population had more than doubled to approximately 60 million in 2000. The number of females was greater than the number of males in all censuses except in 1960.

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Table 4.1: Age composition of population in Thailand, 1960-2000 (in thousand)

Age group	1960			1970			1980			1990			2000		
	Male	Female	Sex ratio	Male	Female	Sex ratio	Male	Female	Sex ratio	Male	Female	Sex ratio	Male	Female	Sex ratio
0-4	2,141.5	2,105.2	**101.7**	2,863.6	2,797.1	**102.4**	2,497.4	2,359.2	**105.9**	2,314.3	2,182.7	**106.0**	2,266.0	2,105.5	**107.6**
5-14	3,582.2	3,510.6	**102**	4,988.0	4,857.5	**102.7**	5,779.9	5,520.3	**104.7**	5,709.8	5,498.2	**103.8**	5,216.2	4,955.8	**105.3**
15-24	2,479.5	2,444.3	**101.4**	3,150.2	3,245.6	**97.1**	4,705.4	4,892.6	**96.2**	5,737.7	5,635.4	**101.8**	5,127.3	4,978.6	**103.0**
25-44	3,175.5	3,165.0	**100.3**	3,821.2	3,920.0	**97.5**	5,285.1	5,445.0	**97.1**	8,071.5	8,486.0	**95.1**	10,073.3	10,517.5	**95.8**
45-59	1,219.4	1,215.3	**100.3**	1,381.9	1,436.5	**96.2**	2,202.3	2,301.1	**95.7**	3,199.3	3,402.1	**94.0**	4,359.5	4,563.5	**95.5**
60-69	378.3	409.2	**92.4**	474.2	537.0	**88.3**	683.1	748.8	**91.2**	1,151.3	1,268.2	**90.8**	1,641.2	1,841.1	**89.1**
70-79	137.3	178.3	**77**	181.4	257.5	**70.5**	319.4	423.4	**75.4**	471.7	599.0	**78.8**	730.2	886.4	**82.4**
80+	47.3	79.9	**59.3**	47.6	80.5	**59.2**	86.1	150.6	**57.2**	152.3	242.6	**62.8**	210.7	328.2	**64.2**
Total	**13,161.0**	**13,107.8**	**100.4**	**16,908.1**	**17,131.7**	**98.7**	**21,558.6**	**21,840.9**	**98.7**	**26,808.0**	**27,314.0**	**98.1**	**29,624.5**	**30,176.6**	**98.2**
Both sexes	**26,268.8**		**101.7**	**34,039.8**			**43,399.5**	2,359.2		**54,122.0**			**59,801.1**		**107.6**

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Table 4.1 presents the number of Thai population and sex ratios by the age groups for each census. The classification of the total population into age groups was as follows: under 5 years, infant; 5 to 14 years, the school ages; 15 to 24 years, adolescents and young adult; 25 to 44 years, productive ages; 45 to 59 years, late middle age; 60 to 69 years, young old; 70 to 79 years, middle old and 80 years and over, oldest old. The change in the age structure was given by the changing percentages at each age as shown in figure 4.1.

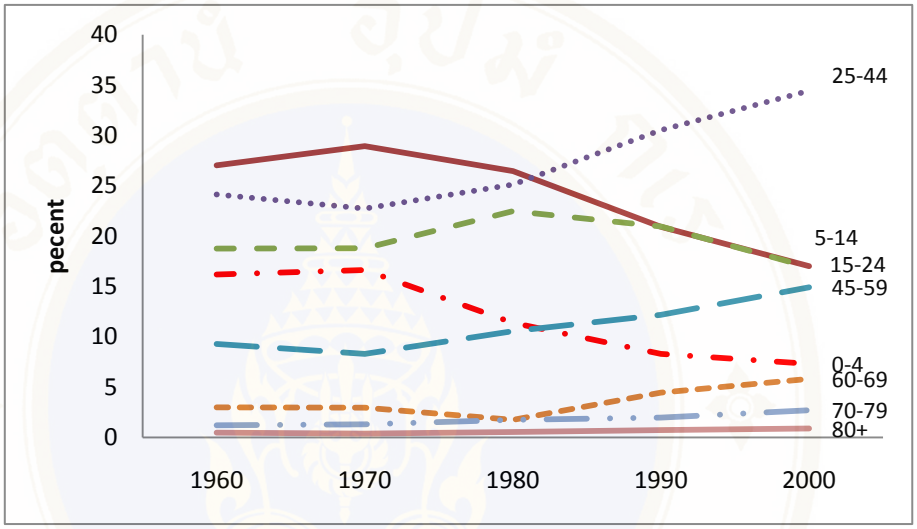

Figure 4.1 Age composition of population in Thailand of both sexes, 1960-2000

In 1960, about 4 million (2 million of each males and females) or 16 percent of total population were aged 0-4 years. Ten years later, the number of infants had increased slightly to 2.9 million of males and 2.8 million of females (16.9 percent of males and 16.3 percent of females). On the other hand, after 1970 the number of infants had decreased significantly and percentage of this age group was less than 10 percent in 2000. The number of people in school ages (5-14 years) follows the same pattern of infant age group. The number of population in this age group decreased from 27 percent in 1960 to 17 percent in 2000. For adolescent young adult who aged 15 to 24 years, the proportion of population during 1960-1980 had been increasing. It increases from 19 percent in 1960 to 22 percent in 1980. After 1980, the proportion of this age group had slightly decreased to 17 percent in 2000. While the number and proportion of people age 0 to 24 years or people at infant and school ages had decreased, the number of population in productive ages (25-44 years) had opposite pattern. It had increased from 3.1 million for each males and females in 1960 to about

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10 million in 2000 or from 24 percent to 34 percent of the total population respectively. Similarly the population in late middle age, 45 to 59 years, had increased continuously from 2.4 million or 9 percent in 1960 to 8.9 million or 15 percent in 2000.

The number of elderly by age group was classified as follows: young old (aged 60-69 years old), middle old (aged 70-79 years old) and oldest old (aged 80 years and over). The number of older females was quite higher than males in every period. It can be explained that women can survive beyond old age than men as the mortality rate of males at working age were higher than females (Siegel and David, 2004). Besides, men had higher risk of dying than women from accident, genes, consumption behavior, some diseases, and from other causes. The percentages of old population in every age group had increased especially at young old age in every year. It had increased from 3.0 percent in 1960 to 5.8 percent in 2000. It seems that the youngest old age growed faster than other groups while the elderly at middle and oldest old had lesser acceleration than young old age but the percent changes maybe greater for oldest group. Moreover, the increases in the population at old age of three age groups had risen rapidly during 1960 to 2000 as shown in figure 4.1.

The sex ratios are presented in table 4.1. The sex ratio is one of the measures of sex composition, which is most widely used to evaluate the number of population. It is usually defined as the ratios of the number of males per the number of 100 females. The value of one hundred is the point of balance of both sexes. Sex ratios above 100 mean an excess of males while sex ratios below 100 mean excess of females. The sex ratio at birth is typically around 105 males per females (Prasartkul, 2002).

The number and proportion of males at the earliest and age at school ages were greater than the number of females. However, after adolescence age the number of females was greater than males. This is due to women have lower death rates than men at every age. Accordingly, the sex ratios of Thai population who aged less than five years were greater than 100 and have increased over time during 1960-2000. It means that the number of males aged 0-4 years was higher than females. It is due to declines in infant and child mortality. Likewise the sex ratios of people in school ages (5-14 years) were also greater than 100. Moreover, after adolescence, age 25-44, the

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number of females was greater than males every year except the number of people age in 1960. The sex ratios at older ages tend to decrease less than 100. It means that the number of female elderly is greater than males due to lower mortality for females than males.

However, the trends in the numbers of both sexes during five decades were quite similar. In summary, the sex ratios of Thai population were highest at the very young ages because of greater sex ratio at birth—there were males born than females. Then the sex ratios tend to decrease with increasing age because of greater male deaths at every age, especially during the working and older ages.

In addition to the functional age groups shown above, the age-sex composition could be classified by three categories; child age group; 0 to 14 years, labor force age group; 15-59 and old age; 60 years and over. These age groups, shown in figure 4.2 revealed that the percentage of population age 0-14 had decreased from 43.2 to 24.3 percent while the percentage of people aged 15-49 years had decreased slightly from 52 percent in 1960 to 50 percent in 1970. Then the population in the working age had increased to 66 percent in 2000. Meanwhile people aged 60 years and over had increased continuously and double increased from 4.7 in 1960 to 9.4 percent in 2000. As the result, the number of elderly had been increasing while the number of children had been decreasing significantly.

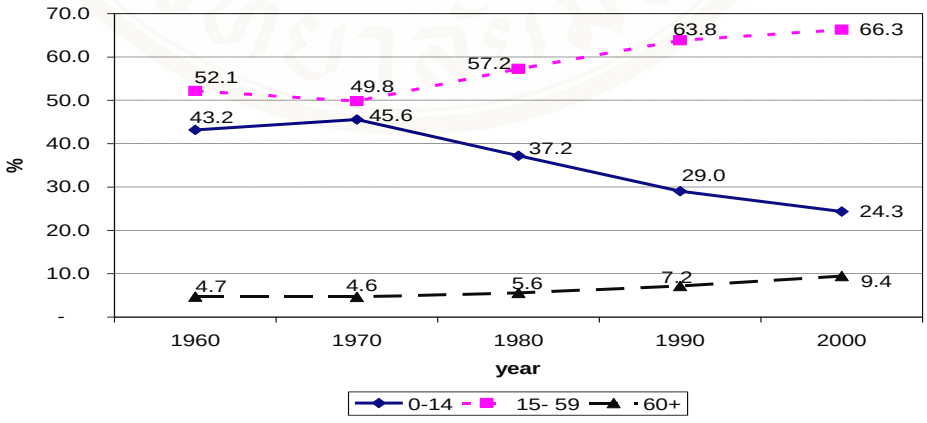

Figure 4.2: The percentage of population by age group from 1960 to 2000, Thailand

These changes in age composition have been interpreted as the demographic dividend (Rowland, 2006). The changing of age structure occurs due to the reduction of fertility leads to an increasing share of the population in the working

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ages and at older ages. This trend is also due, to a lessen extent, because of declining mortality.

The dividend is because the numbers in the working ages increases rapidly relative to those in the dependent ages. This phenomenon means that there are more potential funds for investment in education, economic development and family welfare. In general, per capita income will also rise as a result of this demographic change (Lundberg & Lam, 2007). At the second stage, the working age population will grow more slowly than dependent population because of the rapid growth of the elderly. These dynamics are the result of the success in reducing both birth and infant deaths. It can be explained more by the dependency ratios.

The greater increasing of old population than that of young population as shown in figure 4.2 led to people in working age supported old population than young population. It can be explained these evidences by the dependency ratios.

Dependency ratio is one of important indicators that can measure the changing of age composition. The dependency ratio represents the relationship between the numbers of dependents and supporters. The dependents are people who are young or too old to work. The supporters mean people at working ages. Therefore the total dependency ratio means the number of people in the workforce to the number of people who are too young and too old to work. Generally, it refers as the number of population aged below 15 and above 60 years divided by the number of working aged 15 to 59 years. The result will show the number of dependents per 100 supporters. If the result shows the high ratio, it means there are a lot of dependents when compared with people in the workforce.

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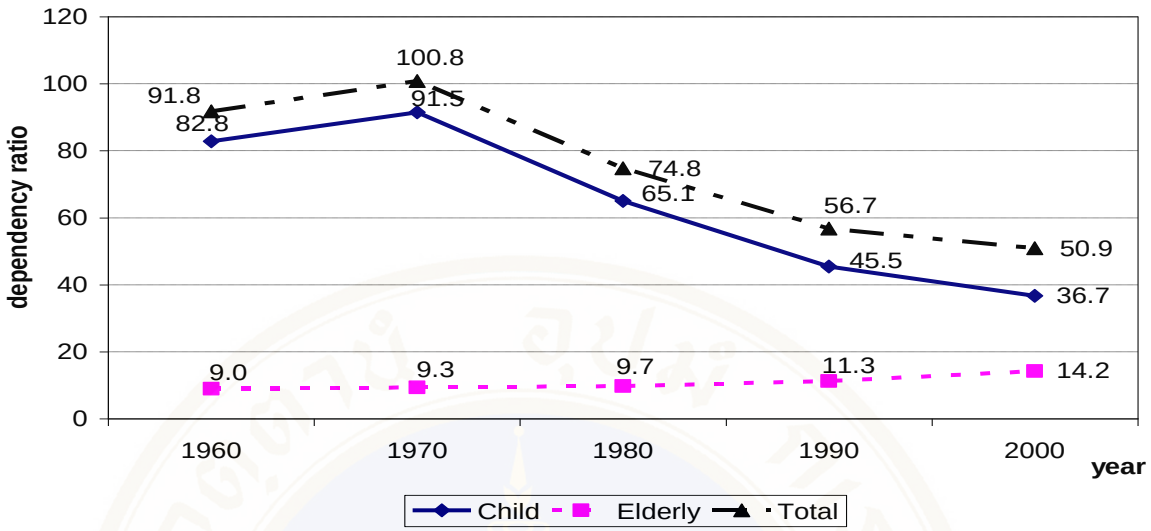

Figure 4.3: the comparison between child and older population dependency ratio in 1960-2000, Thailand

Figure 4.3 shows the total dependency ratios, youth and old population dependency ratios in Thailand 1960-2000. It is found that there were 92 dependants per 100 workers in 1960. Ten years later, the number of dependants had increased gradually to more than the number of those in the working age. The total dependency ratios were still high in the past because people still had many children. In 1980 this ratio had decreased and still reduced continuously at 37 dependants per 100 supporters in 2000. The causes of changing may be due to the reduction of fertility and mortality in Thailand. Mortality improvements lead to increased numbers of the elderly. However, the dependency ratios can be separated in youth and elderly dependency.

The youth dependency ratio is the number of people who are aged less than 15 years per 100 people aged 15-59 years. During 1960-1970 the youth dependency ratios were very high more than 80 young people per 100 in the working ages. This high youth dependency ratio is due to high fertility in the recent past as woman has 6 children during their reproductive ages (Prasartkul & Vapattanawong, 2005). When Thailand's success in the contraception in the 1970s, birth reduction and the youth dependency ratio had decreased from 92 in 1970 to 65 in 1980 and finally to less than 40 dependent youth per 100 persons in the working ages in 2000. At the same time, the elderly dependency ratio, the number of people aged 60 years and over

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per the 100 people aged 15-59 years, had increased from 9 in 1960 to 14 elderly per 100 persons in the working ages in 2000. It is indicated that the number of elderly increases dramatically and it causes an ageing population. In the future, the old age dependency ratio will continue to rise and eventually match the level of child dependency ratio. The change in the dependency ratio from child dependants to elderly dependants has shifted the burden on working age population. They have fewer children to support but increasingly have to support the elderly.

This review indicates that the accuracy of census data is very important for studying age structure of population. The trends in age structure of census in Thailand show that Thailand is rapidly becoming an older society. It seems that in the future, the number of elderly will be increase dramatically.

4.2 Estimates of mortality by using survival ratios from several sources

Survival ratio is often used to estimate the number of centenarians and the oldest old. However, the incompleteness of mortality data may effect to estimate the number of these people. One of problem on studying mortality is the completeness of mortality data especially at high ages (Gavrilova & Gavrilov, 2011; Vapattanawong & Prasartkul, 2009). The unreliable data on deaths is found regularly. Indirect method is another choice to make improved estimates of mortality. Thus, in this part, the several different methods were employed to estimate the number of the old ages. Most studies use survival ratios to estimate probability of mortality by two methodologies: the census survival ratio and life table survival ratio (Siegel, et al., 2004; United Nations, 2002).

The first method is census survival ratio. It is the most widely applicable methods of estimating adult mortality (United Nations, 2002). It is estimated from two decennial censuses. Another method is life table survival ratio. It is constructed by Thai demographic statisticians. The life tables are generally based on direct measures of age-specific mortality (Siegel, et al., 2004). To measure the quality of both methods, the survival ratios are used to compare with the levels (based on model life table) of mortality for the same “inter-censal” intervals.

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In this study the quality of census survival ratios and life tables are evaluated by four methods. The first method derived from the 1960 to 2000 Thailand censuses is used to calculate by census survival ratio. It can be estimated from the survival ratios for each age cohort over an intercensal period (United Nations, 2002). The Thailand life table from SPC in the period of 1964-1966 to 2005-2006 is the second method. The number of survivors in an age interval is used for calculating the probability of surviving. Another method is to borrow the probability of surviving from the Coale-Demeny model West life tables (Coale & Demeny, 1966). The last method is based on the United Nation World Population Prospects from 1960-2010 by using the number of population and Thailand life expectancy at age 60.

To present the results based on four methods, each method is classified by two parts. The first part presents the estimates of old age mortality by the 10-year survival rates of persons. The age groups are showed as those aged 60 years and over surviving to 70 years and over, 70 years and over surviving to 80 years and over, and lastly 80 years and over surviving to 90 years and over. The estimates of younger age starting from age 15-24 years surviving to 35-34 years until age 45-49 years surviving to age 55-59 years are presented in the next part. After presenting every method, the suitable method is selected for estimating the number of centenarians and oldest old in Thailand.

The following steps were used to estimate the number of centenarians and the oldest old in Thailand as shown in figure 4.4.

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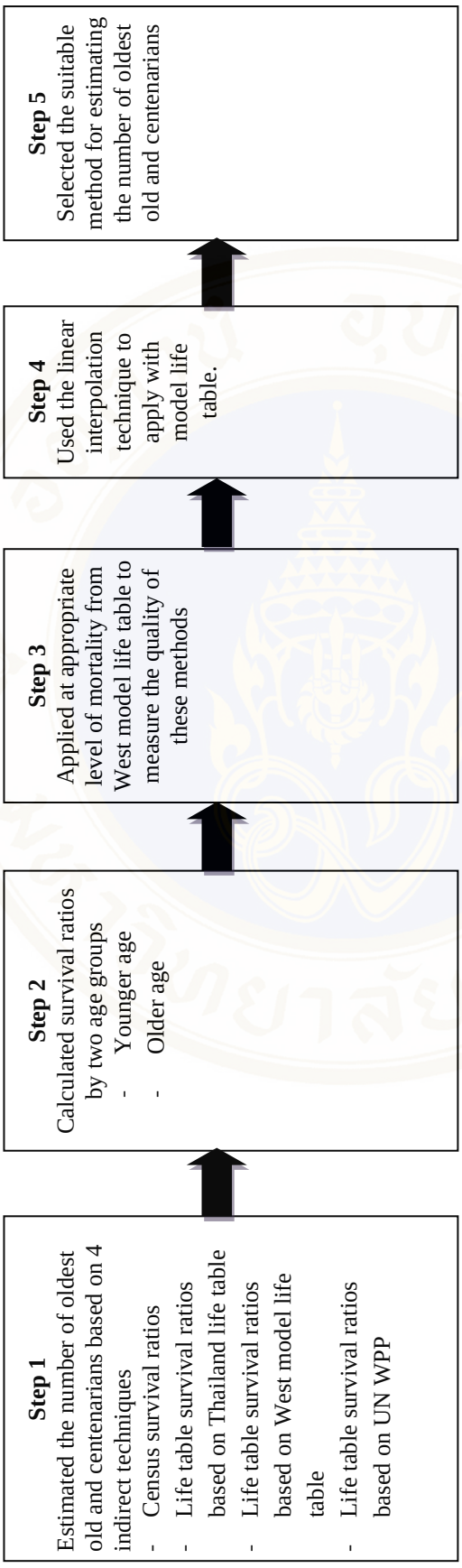

Figure 4.4: The steps used to estimate the number of centenarians and oldest old in Thailand

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4.2.1 Mortality estimates based on census survival ratios (CSR)

The first estimate of mortality is based on census survival ratio (CSR). It can be estimated indirectly from the survivorship between two censuses. In this study, the number of census population during the period 1960-2000 is required at two points in time. It has presented for five-year age groups to extend into very old aged, with an open-ended group of 95 years old or higher. The finding are presented into two groups, older and younger age group and calculated for male and female because the pattern of mortality of both sexes is different.

The Coale and Demeny regional model life tables are applied for estimating mortality level on CSR. Besides, the reconstruction of a new regional model life tables based on Coale and Gua model life table (1989) are also used for high mortality level. It can explain and analysis the pattern of mortality at oldest old very well. Therefore, this method can be applied by comparing the survival ratio from one census to another census with the survival ratios from West model life table.

Furthermore, the linear interpolation technique is used to apply with model life table. The interpolating between two values of survival ratios leads to the accuracy of estimates mortality.

4.2.1.1 Estimates mortality at older age

This section presents mortality estimation at older age by using census survival ratios. The number of population by ten years inter-censal censuses at age 60 years and over to 95 years and over during 1960-2000 is used to estimate the pattern of mortality. The census survival ratio for old population will present cumulative survival ratios at one census to the next ten-year census. It can be calculated by dividing the number of persons aged 70 years and over at the second census by the number aged 60 years and over at the first census; the number aged 80 years and over at the second census by the number aged 70 years and over at the first census, and so on. The use of cumulative survival ratios cause to reduce the effect of age misreporting at the old age.

Table 4.2 and table 4.3 presented the 10-year census survival ratios of males and females. For each inter-censal interval, values of census survival ratios were associated with a specific level following West model life table of Coale and Demeny

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(1983). In general, the patterns of survival ratios of males and females were similar. Besides, people in youngest old were more likely to survive than people in middle old and highest old age groups.

Table 4.2: Census survival ratios of older males and associated the model life table level between census in Thailand, 1960-2000.

Male	CSR	1960-1970	CSR	1970-1980	CSR	1980-1990	CSR	1990-2000
Age group		Implied level		Implied level		Implied level		Implied level
60+to70+	0.407	15.3	0.577	-	0.573	-	0.530	25.7
70+to80+	0.258	21.1	0.376	26.7	0.376	26.7	0.338	25.6
80+to90+	0.119	24.9	0.255	-	0.212	-	0.176	-
Average level		**20.4**		**26.7**		**26.7**		**25.7**

Table 4.3: Census survival ratios of older females and associated the model life table level between census in Thailand, 1960-2000.

Female	CSR	1960-1970	CSR	1970-1980	CSR	1980-1990	CSR	1990-2000
Age group		Implied level		Implied level		Implied level		Implied level
60+to70+	0.506	22.1	0.656	-	0.636	-	0.576	24.8
70+to80+	0.312	22.4	0.445	26.3	0.423	26.6	0.390	24.7
80+to90+	0.167	24.9	0.259	-	0.236	-	0.184	25.5
Average level		**23.1**		**26.3**		**26.3**		**25.0**

The survival ratios at every inter-censal intervals in 1970 to1980 were more likely to increase from 1960 to 1970 and then had slightly decreased in 1980 to 1990 and decreased continuously in 1990 to 2000. The levels of mortality associated with the different survival ratios for the same interval were inconsistent, especially for the 1960 to 1970 decade. The implied levels of old age mortality in Thailand were too low (the index values are too high) to be plausible. For example, the levels of old age mortality in 1960 to 1970 of males varied widely between age groups with an average index value of about 20.4. On the other hand the levels of mortality of female every age group was quite close to the overall average level of mortality about 23.1. Therefore, the 1960 to 1970 census survival ratios for the oldest ages implied a much lower level of old age mortality than would be consistent with the independent

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estimates of a life expectancy of 41.7 for men and 45.5 for women. It could be concluded that the census survival ratios estimates of old age mortality for 1960 to 1970 were much too low.

The index values of mortality levels of both sexes based on the period of 1970-1980, 1980-1990 and 1990-2000 were too high at an average level of 26. Some age groups especially in 1970-1980, and 1980-1990 were shown much high degree of mortality level when compared with West model life table. Some values cannot identify the level of mortality because it is higher than model life table. There is little sign of change in the survival ratios of old population overtime.

The causes of these errors may occur from the effect of age exaggeration at old age. The study of Luther, Dhanasakdi and Arnold (1986) are found that the age exaggeration occurred in the older ages in 1960, 1970, and 1980 in Thailand censuses. The under or over-enumeration of population censuses also leaded to inaccuracy of censuses. Some elderly might be enumerated twice or more due to mobility of the population. Therefore, the census survival ratios do not provide accurate estimates of old age mortality.

These errors in the survival ratios generally occur when census enumerations are inconsistent. It may also occur from age misreporting at the oldest age. The estimates derived from census survival ratios are overestimated because of the inaccuracies in the two censuses. Therefore the incompleteness of the result may happen from the error of two censuses.

4.2.1.2 Estimates mortality at younger ages

This section presents census survival ratios of younger age group to compare with those of older age from the proceeding section. The estimates mortality at younger age is based on the census survival ratios at age 15 to 55 years by five-year age group each inter-censal interval. It can be calculated by the number of people aged 15-24 in 1960 survive to aged 25-29 years in 1970; the number of people aged 25-29 in 1960 survive to aged 35-39 years in 1970 and so on. The objective in this section is to evaluate the quality and consistency of census data at younger ages for the estimation of mortality.

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Table 4.4: Census survival ratios of younger males and associated the model life table level between census in Thailand, 1960-2000.

Male	CSR	1960-1970	CSR	1970-1980	CSR	1980-1990	CSR	1990-2000
Age group		Implied level		Implied level		Implied level		Implied level
15-24	0.8628	3.4	0.9358	12.0	0.9485	14.1	0.9043	7.7
25-34	0.9143	12.1	1.0180	-	1.0819	-	1.0438	-
35-44	0.8309	8.3	0.9559	20.7	1.0838	-	1.0259	-
45-54	0.7321	7.2	0.9281	22.9	1.0109	-	0.8744	18.2
Average level		**6.9**		**14.5**		**14.1**		**9.1**

Table 4.5: Census survival ratios of younger females and associated the model life Table level between census in Thailand, 1960-2000.

Female	CSR	1960-1970	CSR	1970-1980	CSR	1980-1990	CSR	1990-2000
Age group		Implied level		Implied level		Implied level		Implied level
15-24	0.9206	9.6	0.9524	14.4	0.9930	22.4	0.9306	11.0
25-34	0.9076	10.7	0.9808	20.9	1.0891	-	1.0350	-
35-44	0.8570	7.9	0.9909	26.3	1.1167	-	0.9827	23.6
45-54	0.7896	7.2	0.9307	21.0	1.0386	-	0.9372	21.6
Average level		**6.5**		**17.1**		**22.4**		**15.1**

Table 4.4 and table 4.5 show the census survival ratios each interval during 1960-2000 fluctuated wildly across age groups of both sexes especially during 1960-1970. The values of each interval showed the varied level of mortality. It is also found that some of the survival ratios during 1970 to 2000 at some age groups were greater than one. For example, the census survival ratios of the 25-35, 35-45 and 45-55 age groups during 1970-1980 were above one. It is impossible for the survival ratios to be higher than one because this study has already eliminated the effect of migration. Therefore, the estimates of census survival ratios at younger age group are incorrect and reveal inaccurate measurements of age and completeness of evaluation. Besides, the high values of survival ratios might reflect from the under enumeration at the previous period. The one census may enumerate population more completely than another census. Generally, the under enumeration was found in every census especially in 1960 (Luther & Dhanasakdi, 1986). The under enumeration in 1960 was found much more than other periods because the census questions asked the year of birth on animal year and ask with household member (Knodel & Chayovan, 1991). Besides, the quality of age distribution data in two censuses used for estimating

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survival ratio in this study leads to the accuracy of data. For the 1960, 1970, 1980 and 1990 censuses, the main method of data collection was field interview. So the under enumeration may occur during field interview. Besides, the different census reference dates each inter-censal interval probably affect to the value of survival ratios as well. Thus, all of these reasons may lead to the inaccuracy of census data.

This survival ratio may have some errors depending on the quality of two censuses. It is not suitable to estimating the number of centenarians in Thailand because the age misstatements are found in census especially in extreme age. Moreover, the number of centenarians is not recorded in census. The highest age in census are shown at 85 years and over only.

According to the result, the census survival ratios of both older and younger age group are seemed to be inaccurate because of the inconsistencies in age-sex distribution. The result of the following two sections shows that survival ratios fluctuated wildly. Moreover, the level of mortality could not be estimated with survival ratios that were more than one. Thus, the Thai census survival ratio method could not be used to generate reliable estimates of mortality.

Hence, It can be concluded that censuses in each period are found some errors and inaccurate of data because of under enumeration or age exaggeration. These reflect to the coverage error of values in survival ratios both younger age and old age.

4.2.2 Estimate mortality from Thailand life table

The estimation of mortality from Thailand life table is presented by two methods; calculated survival ratios from Thailand life table and based on the West model life table.

The most general use of life table is to measure the level of mortality of a given population. Life table is a tool in the mortality analysis that could be performed on the basis of life table values.

The Thai life tables offer an alternative to estimate mortality by the survival rates from life table. This method is based on calculating survival ratios from Thailand life table. Calculating survival ratios from Thai life table are derived from The Survey of Population Change of Thailand (SPC) during 1964-1966, 1975-1976, 1985-1986, 1995-1996, and 2005-2006 which was undertaken by NSO, Thailand.

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Furthermore, the West model life tables of both sexes are used to evaluate the quality of mortality estimates based on the Thai life table. Life table survival ratios also apply linear interpolation technique to adjust the level of mortality.

4.2.2.1 Estimates mortality at older age

The objective of this section is to calculate survival ratios of the old age population based on the value of the total number of person-years lived from exact age x at T_x column in life table. According to the highest age groups in Thailand life table is 80 years and over, so the survival ratios of 70 years old would be expected to age is the final age group.

The survival ratios shown in table 4.6 and 4.7 fluctuated for the period of 1960-1970 to 2000-2010. The survival ratios for the young old age group were greater than extreme age group. Besides the mortality levels of females had improved more than males over time, which indicated that women live longer than men.

The levels of mortality at older age for particular period were quite similar for both sexes. For the 1960-1970 periods, the levels of mortality seem too low for both sexes. The life table survival ratios correspond to level 4 in males and level 6 in females (model life table). For during 1970-1980, the survival ratios were much higher such as survival ratios of males at aged 60 years and over to age 70 years and over increased from 0.26785 during 1960-1970 to 0.46672 during 1970-1980. At the same time, the average values of survival ratios of both sexes can be implied to mortality level 23, associated with a life expectancy at birth in the West model life table of about 71 years old of males and 75 years old of females. It seems that this level of mortality is too high relative to independent estimates of Thai mortality.

During the period of 1980-1990, the survival ratios tend to decrease slightly from the 1970-1980 period. However, the levels of mortality were still high at level 20 of males and level 23 of females. In 1990-2000 periods, the survival rates had increased to a mortality of level 26 for both sexes. The life table survival rates for 2000-2010 were at the same level. Hence, this mortality level is implausible. Some of the survival rates are beyond the level of mortality on the Coale Demeny model life table. Thus, it should be concluded that the survival ratios from Thailand life table are overestimated.

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Table 4.6: Estimates of survival ratios of males, age 60 years and over to 80 years and over based on Thailand life tables, 1960 to 1970, 1970 to 1980, 1980 to 1990 and 1990 to 2000.

Male		1960-1970		1970-1980		1980-1990		1990-2000		2000-2010
Age group	LTSR	Implied level	LTSR	Implied level	LTSR	Implied level	LTSR	Implied level	LTSR	Implied level
60+to70+	0.2679	3.2	0.4667	22.1	0.4450	20.1	0.5556	26.5	0.5334	25.8
70+to80+	0.1121	4.4	0.3134	24.7	0.2503	20.4	0.4369	-	0.3756	26.7
average level		**3.8**		**23.4**		**20.3**		**26.5**		**26.3**

Table 4.7: Estimates of survival ratios of females, age 60 years and over to 80 years and over based on Thailand life tables, 1960 to 1970, 1970 to 1980, 1980 to 1990 and 1990 to 2000.

Female		1960-1970		1970-1980		1980-1990		1990-2000		2000-2010
Age group	LTSR	Implied level	LTSR	Implied level	LTSR	Implied level	LTSR	Implied level	LTSR	Implied level
60+to70+	0.3360	5.6	0.5208	22.8	0.5134	22.4	0.6081	26.0	0.5716	27.2
70+to80+	0.1598	6.6	0.3526	23.8	0.3255	23.0	0.5093	-	0.4083	27.6
average level		**6.1**		**23.3**		**22.7**		**26.0**		**27.4**

4.2.2.2 Estimates mortality at younger ages

The objective of this section is to calculate survival ratios for younger age based on the population at time x per population at time x+n by using L_x column. For example, the people aged 15-19 years survive to age 25-29 years in the next 10 years.

The pattern of young old in table 4.8 and 4.9 showed the highest value of survival ratios at the age 15-24 years of both sexes. The survival ratios had decreased as age increased. The probability of mortality of females was greater than males in every period and in every age group. It indicates the higher level of male mortality in every period. Besides, the survival ratios of females tend to increase continuously although the value of some age group, 15-24, 25-34, has decreased during 1990-2000 but it increased in 2000-2010. The probability of mortality of males showed fluctuations from period 1960-1970 to 2000-2010 every age group. The survival ratios of males during 2000-2010 tended to decrease every age group.

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Table 4.8: Estimates of survival ratios of males, age 15-24 to 45-54, based on Thailand life tables, 1960 to 1970, 1970 to 1980, 1980 to 1990 and 1990 to 2000.

Male		1960-1970		1970-1980		1980-1990		1990-2000		2000-2010
Age group	LTSR	Implied level	LTSR	Implied level	LTSR	Implied level	LTSR	Implied level	LTSR	Implied level
15-24	0.9008	7.3	0.9731	19.0	0.9785	20.2	0.9767	19.8	0.9760	19.6
25-34	0.8749	8.0	0.9476	16.4	0.9647	19.0	0.9682	19.5	0.9626	18.6
35-44	0.8242	7.9	0.9143	15.9	0.9483	19.8	0.9571	20.9	0.9440	19.2
45-54	0.7095	6.0	0.8577	16.7	0.8947	20.2	0.9206	22.3	0.9064	21.3
Average level		**7.3**		**17.0**		**19.8**		**20.6**		**19.7**

Table 4.9: Estimates of survival ratios of females, age 15-54, based on Thailand life tables, 1960 to 1970, 1970 to 1980, 1980 to 1990 and 1990 to 2000.

Female		1960-1970		1970-1980		1980-1990		1990-2000		2000-2010
Age group	LTSR	Implied level	LTSR	Implied level	LTSR	Implied level	LTSR	Implied level	LTSR	Implied level
15-24	0.9227	8.9	0.9771	18.8	0.9841	20.2	0.9815	19.7	0.9921	22.1
25-34	0.9058	9.5	0.9680	18.8	0.9809	20.9	0.9771	20.3	0.9853	21.7
35-44	0.8701	8.1	0.9362	16.6	0.9670	21.0	0.9702	21.4	0.9760	22.3
45-54	0.7836	6.8	0.9085	18.4	0.9207	19.8	0.9384	21.7	0.9501	22.8
average level		**8.3**		**18.2**		**20.5**		**20.8**		**22.2**

When considering the level of mortality by age group, the levels were quite similar in every year and the mortality level of females was greater than males in every periods. The level of mortality in 1960-1970 was quite low. When compared with the life expectancy at birth in 1960-1970, the West model life table at level 7 of males and level 8 of females were approximately 32.5 years for males and 37.5 years for females. In fact, the life expectancy at birth of males and females in 1960-1970 was about 41.7 and 45.5 years respectively (Vapattanawong, 2002). However, the mortality level during 1970-1980 and 1980-1990 was closer with the life expectancy at birth of Thai life expectancy. But the mortality levels during 1990-2000 and 2000-2010 were too low. Thus it should be noted that mortality at young old of females are greater than males. Women in the young old tend to live longer than men, especially during 2000-2010.

The estimates of mortality for older and younger old age group by the survival ratios of Thailand life tables do not appear to be reliable. For example, life

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table estimates of old age mortality are implausibly low. The sources of errors in Thai life tables are not examined here, but it appears that under reporting of deaths might be a major problem. It can be concluded that the use of survival ratios from Thai life tables is likely to be over-estimated.

4.2.3 Estimates mortality based on the West model life table

The purpose of this section is to estimate the older age population based on survival ratios from West model life table. This section uses the reported life expectancy at age 60 for old age mortality and uses life table at age 15 for younger age using the data from the Survey of Population Change of Thailand (SPC) during 1964-1966 to 2005-2006 (5 rounds). The West model life table and revised model life table for estimating extreme age group are still used for estimating mortality experience in this section.

4.2.3.1 Estimates mortality at old age

This section focuses on estimates of old age mortality by using the life expectancy at age 60 in Thailand combined with the West model life table. Table 4.10 shows the life table survival ratios and level of mortality of people aged 60 years and over to aged 90 years and over during 1960-2010 for both sexes.

The pattern of life table survival ratios in table 4.10 was similar to census survival ratios in table 4.3. It is found that the survival rates had declined from younger to older ages. For example, the survival ratios of male during 2000-2010 at age 60 years and over to aged 70 years and over was 0.52270 whereas the survival ratios at age 70 years and over to aged 80 years was 0.33137 and 0.12641 at the oldest age group.

The life table survival ratios of older population improved across each interval from 1960-1970 to 2000-2010 for both sexes. The survival ratios of females were higher than those of males for every period. In male cohort aged 60 years and over to 70 years and over, the life table survival ratios had risen from 0.41055 to 0.52270 at the young old, from 0.21412 to 0.33137 at the middle old, from 0.05146 to 0.12641 at the oldest old and from 0.00187 to 0.01747 for nonagenarians and centenarians during 1960-1970 to 2000-2010. At the same periods, the survival ratios

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of females had increased apparently as well such as from 0.51349 to 0.56456 at young old, from 0.31274 to 0.37658 at middle old, from 0.10801 to 0.15070 at the oldest old and from 0.01316 to 0.02162 for nonagenarians and centenarians. When focused on the survival ratios in age interval, most survival ratios had decreased in the period 1980-1990. It can be explained by the effect of the differential level of coverage of mortality and the impact of HIV epidemic on adult mortality in the late 1980s and early 1990s (Hill, et al., 2007).

Table 4.10: The estimates mortality of both sexes at old age based on the West model life table

year	1960-1970		1970-1980		1980-1990		1990-2000		2000-2010	
age group	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
60+to70+	0.41055	0.51349	0.45401	0.50899	0.43943	0.50562	0.53947	0.59524	0.52270	0.56456
70+to80+	0.21412	0.31274	0.25748	0.30828	0.24068	0.30494	0.34919	0.41800	0.33137	0.37658
80+to90+	0.05146	0.10801	0.08115	0.10622	0.06347	0.10487	0.13604	0.18280	0.12641	0.15070
90+to100+	0.00187	0.01316	0.00876	0.01240	0.00259	0.01183	0.01983	0.02967	0.01747	0.02162
Level	**15.8**	**22.4**	**21.0**	**22.2**	**19.4**	**22.0**	**26.0**	**25.5**	**25.4**	**24.4**

Moreover, the mortality levels compared with the West model life table are improving tendency overtime. It has increased from level 15.8 in 1960-1970 to 25.4 in 2000-2010 for males and increased from 22.4 to 24.4 at the same period for female.

When considering on the levels of mortality of both sexes, the levels of female mortality were greater than males but quite close every period. For example, the level of male mortality was 25.4 while the level of female mortality was 24.4 in 2000-2010. Furthermore, the level of mortality in every period is smooth and can be reliable. In some cases, even the level of mortality in some period is too high.

4.2.3.2 Estimates mortality at younger age

The objective of this section is to estimate mortality at younger age by using life expectancy at age 15 in Thailand. The result shown in table 4.11 reported continued progress of mortality of younger age during 1960-2010 for both sexes. Besides, the pattern of life table survival ratios at younger age was the same

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with old age group and the pattern of mortality both sexes were quite similar. Females had greater survival ratio than males in every age group. For youngest age group, the life table survival ratios of males had increased dramatically from 0.96378 at aged 15-24 in 1960-1970 to 0.98599 in 2000-2010. The life table survival ratios of females at the same age group had also risen from 0.98100 to 0.99524 at the same time. Besides, the survival ratios at other age groups had also increased. The youngest old ages were much higher survival ratios than higher age group. For example, the survival ratios at age 15-24 years were 0.96378 whereas the survival ratios at aged 25-34 were 0.95229, at aged 35-44 were 0.92525 and aged 45-54 were 0.86183.

Table 4.11: The estimates mortality of females at young ages by life expectancy at age 15 from Thailand life table

year	1960-1970		1970-1980		1980-1990		1990-2000		2000-2010	
age group	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
15-24	0.96378	0.98100	0.96783	0.98100	0.97650	0.98758	0.98816	0.99521	0.98599	0.99524
25-34	0.95229	0.97269	0.95781	0.97269	0.96963	0.98090	0.98558	0.99143	0.98211	0.99146
35-44	0.92525	0.95742	0.93244	0.95742	0.94812	0.96651	0.97312	0.98295	0.96556	0.98313
45-54	0.86183	0.91850	0.87061	0.91850	0.89027	0.92939	0.92953	0.95777	0.91455	0.95811
Level	17.1	19.6	17.9	19.4	19.7	20.9	23.0	23.7	21.9	23.7

The levels of mortality based on West model life table both males and females were closer and smooth. It had been increasing from 17.1 of males and 19.6 of females during 1960-1970 to 21.9 of males and 23.7 of females during 2000-2010. However the levels of mortality by using life expectancy at age 15 of official Thai life table (SPC) was quite close the level in the West model life table of Coale and Demeny.

The estimates mortality of old age based on life expectancy at age 60 and based on life expectancy at age 15 for younger age from Thailand life table were found to be well smooth. The survival ratios of both old and young age group were shifting over time. The level of mortality could be indicated the mortality progression very well. Although the errors of survival ratios were found some age group but it may not effect to calculate the number of centenarians and oldest old. Therefore, it can be concluded that this method can be used to estimate the number of population at the

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highest ages better than the use of survival ratios calculated from censuses and from the SPC.

4.2.4 Estimates of mortality based on the life table survival ratios from The United Nations World Population Prospects

The purpose of this section is to estimate the probability of surviving based on the life table survival ratios from The United Nations World Population Prospects (UNWPP). To estimate the survival ratios, the population of Thailand and the life expectancy at age 60 and aged 15 estimated by the UNWPP are used. This section uses the reported life expectancy at age 60 for old age mortality and uses life table at age 15 for younger age from the UNWPP during 1964-1966 to 2005-2006 (5 rounds). The West model life table and revised model life table for estimating extreme age group are used for estimating mortality experience in this section.

This section presents the mortality estimation by classifying both the old and younger ages survival ratios as same as other methods that mentioned above.

4.2.4.1 Estimates mortality at older age

Table 4.12 presented survival ratios of people aged 60 years and over to 90 years and over and mortality level implied by the West model life table of Coale and Demeny. The survival ratios of both sexes showed the same pattern of mortality as same as other sources of data. The survival ratios at age 60 years and over to 70 years and over were greater than other ages in every period and lowest at the oldest age group. The survival ratios of females were also higher than those of males in every period.

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Table 4.12: The estimates of survival at older age by using life expectancy at age 60 from UNWPP

year	1960-1970		1970-1980		1980-1990		1990-2000		2000-2010	
age group	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
60+to70+	0.41056	0.50974	0.45472	0.52430	0.44211	0.50749	0.55033	0.58263	0.51941	0.57141
70+to80+	0.21413	0.30902	0.25803	0.32346	0.24321	0.30679	0.36122	0.40091	0.32788	0.38580
80+to90+	0.05146	0.10652	0.08125	0.11233	0.06468	0.10562	0.14265	0.16924	0.12453	0.15772
90+to100+	0.00187	0.01252	0.00868	0.01499	0.00270	0.01214	0.02080	0.02641	0.01700	0.02344
Level	**20.8**	**19.2**	**22.1**	**22.0**	**22.8**	**23.1**	**21.3**	**23.0**	**22.3**	**22.6**

The survival ratios of males had fluctuated from the third period, 1980-1990, through the end of the period, with slightly decreased during 1990-2000 and increased again during 2000-2010. For example, the survival ratios of male at aged 80+ to 90+ in the period of 1960-1970 were 0.05146. It had increased to 0.08125 in the period 1970-1980. After that the survival ratios at the same age had decreased to 0.06468 during 1980-1990, increased to 0.14265 in 1990-2000 and then again decreased to 0.12453 in the last period. Not only survival ratios of males had fluctuated but also the survival ratios of females had slightly decreased at the last period at every age group. It may be explained by the effect of HIV epidemic and over-underestimation of death.

Moreover, the levels of mortality for both sexes were quite close but not smooth. It could be observed that the levels of mortality of males have declined at the period of 1990-2000 from level 22.8 in 1980-1990 to level 21.3 in 1990-2000 and increased to 22.3 in 2000-2010. The levels of female mortality were smooth between the periods of 1960-1970 to 1990-2000 and had slightly decreased in 2000-2010.

Therefore, it can be concluded that the estimates of survival ratios at old age by using life expectancy at age 60 from United Nations had some errors especially the survival ratios and level of mortality during 1990-2000 and 2000-2010. It can be explained by the data based on life expectancy at age 60 from United Nations at both period were quite varied. It did not shift overtime. It makes survival ratios and levels of mortality are inaccurate as well.

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4.2.4.2 Estimates mortality at younger age

An inaccuracy of old age data is found after studied the survival ratios by using UNWPP estimated data. This section presents the estimates of survival ratios at younger age group to evaluate the younger age data of mortality.

This section implies the life expectancy at age 15 from United Nations databases during 1960-2010 to compare with West model life table, which have the same life expectancy at age 15.

Table 4.13: The estimates of survival at young age by life expectancy at birth from United Nations

year	1960-1970		1970-1980		1980-1990		1990-2000		2000-2010	
age group	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
15-24	0.95988	0.96560	0.97028	0.9783	0.98211	0.99054	0.97869	0.99245	0.98015	0.9918
25-34	0.94696	0.95333	0.96115	0.9693	0.97665	0.98496	0.97247	0.98768	0.97427	0.9868
35-44	0.91839	0.93599	0.93685	0.9535	0.95707	0.97184	0.95183	0.97550	0.95408	0.9743
45-54	0.85363	0.89225	0.87607	0.9136	0.90102	0.93763	0.89484	0.94381	0.89749	0.9415
Level	16.3	16.6	18.4	19.0	20.9	21.7	20.2	22.2	20.5	22.0

In table 4.13, the survival ratios of younger ages by 10 year interval were classified age group from 15-54 years age group as same as other methods. The survival ratios of male younger age groups still had fluctuated during 1980-1990 to 2000-2010. The pattern of survival ratios of male younger age was similar with old age that tend to increase from the period 1960-1970 to 1980-1990, then decrease at period 1990-2000 and raised at the end period. While the survival ratios of females were smooth from the first to the fourth period and declined at the period 2000-2010.

The result of survival ratios both older and younger old age group calculated by UNWPP estimated data were found some inaccuracy for both sexes. In general, we would expect lower mortality over time, but the tendency of survival ratios is not smooth. There are some potential reasons this may happen that are the age composition of elderly population may shift over time and age miss-statement may be a confounding factor. Thus it should be noted that the data of mortality from United Nations is not suitable to use for estimating mortality in Thailand.

According to evaluation mortality estimates by using two methods based on census survival ratio, and life table survival ratio from three different sources of

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data. The survivorship borrowed from the West model life table is appropriate for estimating number of centenarians and oldest old in Thailand. Even it shows the high mortality level in some periods but this method is found less error when compared with other sources. Besides, this method can display the mortality progression of Thai population based on life expectancy at age 60 (for older age) and 15 (for younger age) of Thai population. Therefore, the estimates number of centenarians and oldest old in Thailand will be used the life table survival ratio method based on the West model life table.

4.3 New estimates of centenarians and oldest old

After comparing the estimated mortality by using several sources of data, the appropriateness of borrowing the survival ratios from the West model life table are found. The estimated number of centenarians and oldest old in Thailand are presented in this section.

This section presents in three parts. The first section analyzes the estimates mortality based on the West model life table among old age and younger age by explaining the pattern of surviving. The second section presents the improved survival among Thai elderly. The last section displays the estimates number of centenarians, and oldest old in Thailand.

4.3.1 Analysis of probabilities of surviving based on the West model life table among old age and younger age

In this section, the patterns and sex differentials in the probability of surviving for 10 additional years at elderly and younger ages during the period from 1960-1970 to 2000-2010 ($_{10}S_x$) are presented. The probabilities of surviving are "borrowed" from the West model life table with the life table "level" based on the reported life expectancy for that year from the Thai life tables. The survival ratios are reported for 4 elderly age groups (60-70, 70-80, 80-90, and 90-100) and 4 younger age groups (15-24, 25-34, 35-44 and 45-54) for each decade from 1960 to 2000.

When considering on the mortality probability at old age in figure 4.4, the pattern of survival ratios of both sexes was quite similar. The survival ratios varied

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inversely with the age; the younger the age, the higher the ratios. For example, the survival ratios of male for age 60+ to 70+ in 1960-1970 were 0.411 while the survival ratios at middle old age, 70+ to 80+ were 0.214, and 0.002 at oldest old, age 90+to 100+. However, the probability of surviving of both sexes was improved. It was shown that the survival lines were increased sharply in every period especially between the period of 1980 to 1990 and 1990 to 2000. It may be due to the effect of HIV-AIDS mortality in the 1980s and 1990s, with a major influence in males and a slowing effect in females (Hill, et al., 2007). Furthermore, the survival ratios of females were greater than males in every age interval as well. It can be explained by the highest gains in female life expectancy at birth and longer live.

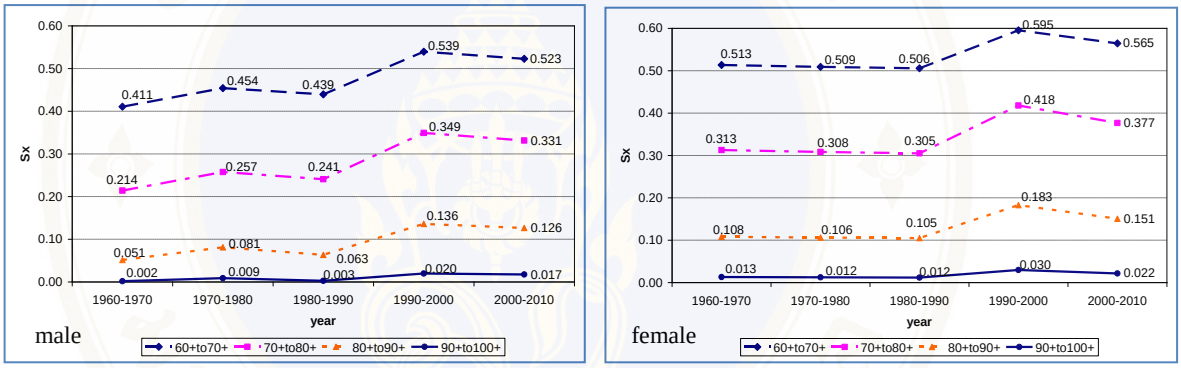

Figure 4.5: The estimates mortality of both sexes at age 60+to70+, 70+to80+, 80+to90+ and 90+to 100+ based on life expectancy at age 60 from Thai life table

For estimating mortality at younger age, age 15-24, 25-34, 35-34 and 45-54 in figure 4.6, the pattern of survival ratio of both sexes were similar, and the probability of surviving varied inversely as old age. The probability of surviving of both sexes improved over time but the rates had little deceased at the last period. The survival ratios of younger females were greater than males in every age interval as well. Observably, the survival lines at age 15-24 to 35-44 of both sexes were quite close while the survival line at age 45-54 was widen from survival line of age 35-44 especially at male survival line. It means that people in reproductive age (45 to 59 years) were more likely to die than people in school age (15-24 years), and young adult (25-44 years).

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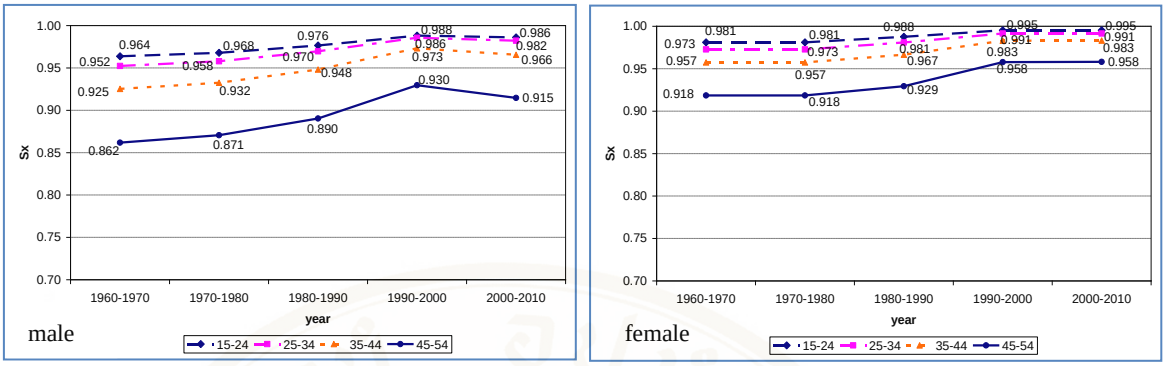

Figure 4.6: The estimates mortality of both sexes at younger age based on life expectancy at age 15 from Thai life table

4.3.2 The improved survival among Thai elderly

The aim of this section is to investigate the improved survival among Thai elderly by generation as classified by birth cohorts into three age groups, young old (60-69 years), middle old (70-79 years), and oldest old (80 years and over). There are two generations based on five birth cohorts from three age groups.

First generation is called younger generation. It means those elderly who were surviving in 1960-1970 based on three age groups. This generation to be investigated is:

1) Those elderly aged 60-69 years who born in 1900-1910
2) Those elderly aged 70-79 years who born in 1880-1890
3) Those elderly aged 80 years and over who born before 1890

Another generation is called later generation. It means those elderly who were surviving in 2000-2010. This generation to be investigated is:

1) Those elderly aged 60-69 years who born in 1930-1940
2) Those elderly aged 70-79 years who born in 1910-1920
3) Those elderly aged 80 years and over who born before 1920

The survival probability of those birth cohorts is investigated separating by sex as shown in figure 4.7 and 4.8.

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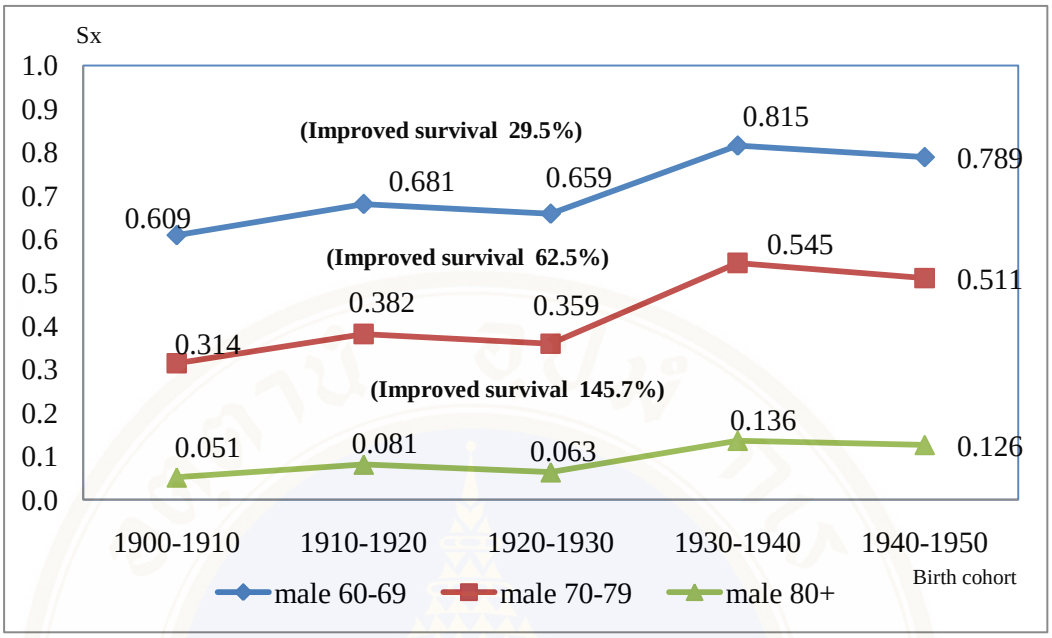

Figure 4.7: The probability of surviving of males during 1960-2010

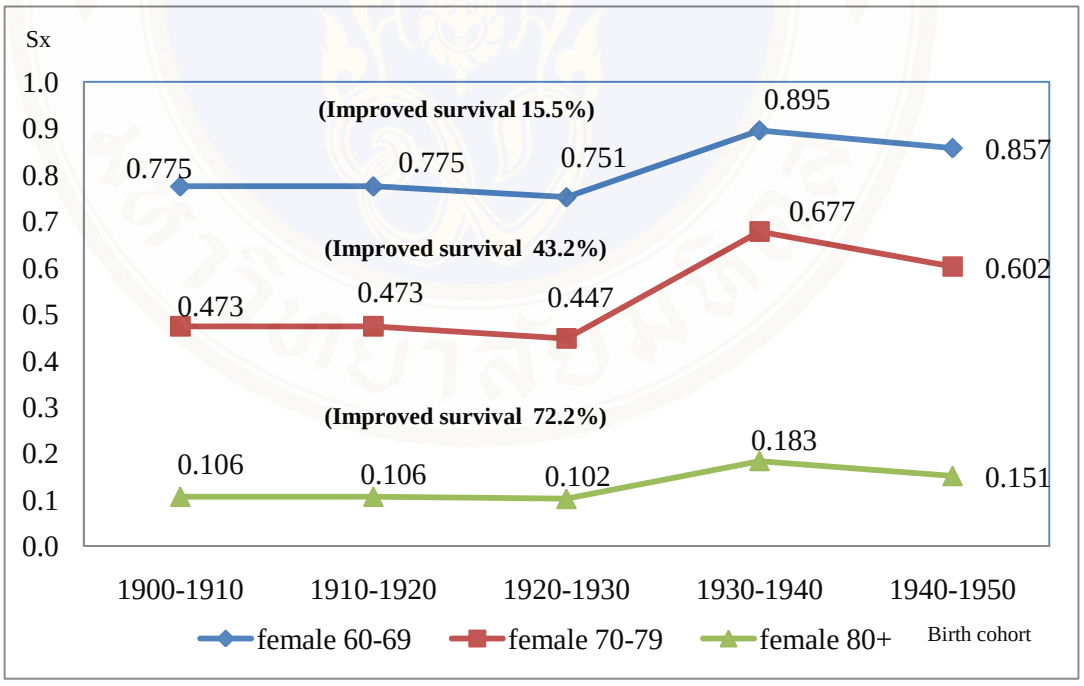

Figure 4.8: The probability of surviving of female during 1960-2010

The survival graphs of both sexes shown in figure 4.7 and 4.8 were classified into three age groups, young old (60-69 years), middle old (70-79 years) and oldest old (80 years and over). It was found that the survival ratios varied inversely by

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age that means the younger, the higher ratios of survival. The survival ratios in every age group of both sexes were more likely to increase during the period of 1960-2010. It indicates that the elderly in the later generation every birth cohorts have higher survival rates compared to the younger generation. However, some interval age group fluctuated wildly across the age groups especially during the 1960s to 1980s. It can be explained by the improved mortality of the Thai population during that time as a result of the declines in infant mortality and the improvement of old age mortality. In addition, the survival ratios of females were greater than the rates of males in every age group through time.

When focusing on the survival ratios between the two generations in each birth cohort (younger generation each age group in 1960-1970, and later generation in 2000-2010), the increase of probability of surviving was found during four decades (1960-1970 to 2000-2010). The survival ratios of young old that were in younger generation (born in 1900-1910) were 0.609 of male, and 0.775 of female. When comparing with the survival ratios of the later generation (born in 1930-1940), the rates of survival were more likely to improve as 0.789 of male, and 0.857 of female. It can be noted that the increase rates or percentage change of the probability of surviving at younger generation during four decades was about 29.5 percent of male and 15.5 percent of female. While the survival rates of middle old were more likely to increase as well. The survival ratios of middle old that were in young generation (born in 1880-1890) were 0.314 of males and 0.473 of females while the survival ratios of later generation (born in 1910-1920) were 0.511, and 0.602 respectively. The percentage change of survival ratios at middle old was 62.5 and 43.2 percent. Besides, the probabilities of surviving of oldest old who were in old generation (born before 1920) were more likely to survive than the young generation (born before 1890) as well. The survival of young generation at oldest old was 0.051 for male and 0.106 for female while the later generation was 0.126, and 0.151 respectively. The percentage change of surviving at oldest old was 145.7 percent of male, and 72.2 percent of female. However, it can be concluded that the increase rate or percentage change of survival ratio among male were higher than that of females in every age group. Finally, compared to the survival ratios in other elderly age group, the ratio of elderly aged 80 and over, the oldest old, increase greatest.

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In summary, the later generation among elderly in every age group was more likely to survive than the young generation. It probably due to the medical technology and public health services has been dramatically developing during the past three decades. In addition, the degree of urbanization and well-being of population have become higher, whereas fertility and mortality have been decreasing throughout time. These phenomena cause an ageing population. Moreover, the improved survival of oldest old for both sexes has increased greatest than other age group especially the improved survival of male. Thus, it can be concluded that elderly nowadays can live longer than the past. The improvement in mortality reduction has been causing the largest gains in oldest old surviving than youngest old age.

4.3.3 Estimates number of centenarians, and oldest old in Thailand

This section focuses on the estimates number of centenarians, and oldest old in Thailand. The cohort survival ratios were based on the West model life table. When the survival ratios are obtained as mentioned above, the initial census population for each year was multiplied by the survival ratio to estimate the number of survivors ten years later. The starting point for estimation of survival ratios was the age 40-44, 45-49, 50-54, 55-59, 60-64 and 65-69 years in 1970 to age 80-84, 85-89, 90-94, 95-99, and 100-104 years, respectively in 2010.

The cohort survival ratios from decade to decade by borrowing values from each period life table based on the West model life table were used. It is shown the cohort survival ratios by the 5-year survival ratios during five decades. To get the estimated number of centenarians in 2010, the estimation was started from the survival ratios at ages 30-34, 35-39, 40-44, 45-49, 50-54, and 55-59 in 1960-1970 to ages 70-74, 75-79, 80-84, 85-89, and 90-94 in 2000-2010.

The life expectancy at age 60 for each inter-censual interval were derived from The Survey of Population Change of Thailand during 1964-1966, 1975-1976, 1985-1986 1995-1996, and 2005-2006 undertaken by National Statistics Office of Thailand. This method was based the estimated e_{60} from official Thai life tables and using this value to select the level of the West model life table consistent with reported e_{60}. After that the linear interpolation technique was used to adjust the level of

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mortality and then the survival ratios based on the West model life table were obtained.

4.3.4 Step in estimating the centenarians

This study used the life table survival ratios (S_x) based on West model life table to estimate the number of centenarians in 2010. Coale and Guo's (1991) new regional West model life tables were employed to estimate in this study. The 2005-2006 SPC life expectancies at age 60 (e_{60}) of both sexes were used to estimate the level of mortality of the West model life table. Linear interpolation technique was used to obtain an appropriate level of mortality of the West model life table that corresponding to the e_{60} from the SPC life table. Survival ratio (S_x) presented the probability of surviving from a younger age to an older age. Survival ratios at age 90 (S_{90}) of both sexes were used to estimate the number of centenarians in 2010. It was computed by using the values of total number of person years at age x+n (T_{x+n}) divided by those at age x (T_x) from the appropriate level of mortality of West model life table. The S_{90} of both sexes were then multiplied by population at aged 90 years and over in 2000 census to get the estimated number of centenarians in 2010. Steps to estimate the number of centenarians in Thailand were listed in figure 4.9 as follows.

Step 1: e_{60} from the SPC life table in 2005-2006 was used. Since this study focused on the elderly population, e_{60} was chosen based on an assumption that the life expectancy at this old age is unaffected by mortality at younger ages especially during the infancy and childhood.

Step 2: e_{60} from SPC life table are applied at corresponding level of mortality of the West model life table.

Step 3: Interpolate the mortality level using West model life table to get appropriate mortality level for Thailand for male and female separately.

Step 4: Calculate Thai S_{90} by using T_x from the West model life table at corresponding level obtained in step 3. The S_{90} are derived by taking the T_{100} as the numerator and the T_{90} as the denominator. ($\frac{T100}{T90}$)

Step 5: Estimate number of centenarians in 2010 ($_{2010}P_{100+}$) by multiplying interpolated Thai survival ratios (step 4) by population aged 90+ from the 2000 census ($_{2000}P_{90+}$). This calculation followed formula below.

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$$_{2010}P_{100+} = {}_{\infty}S^{10}_{90} \times {}_{2000}P_{90+} \quad \text{or} \quad \frac{T100}{T90} \times {}_{2000}P_{90+}$$

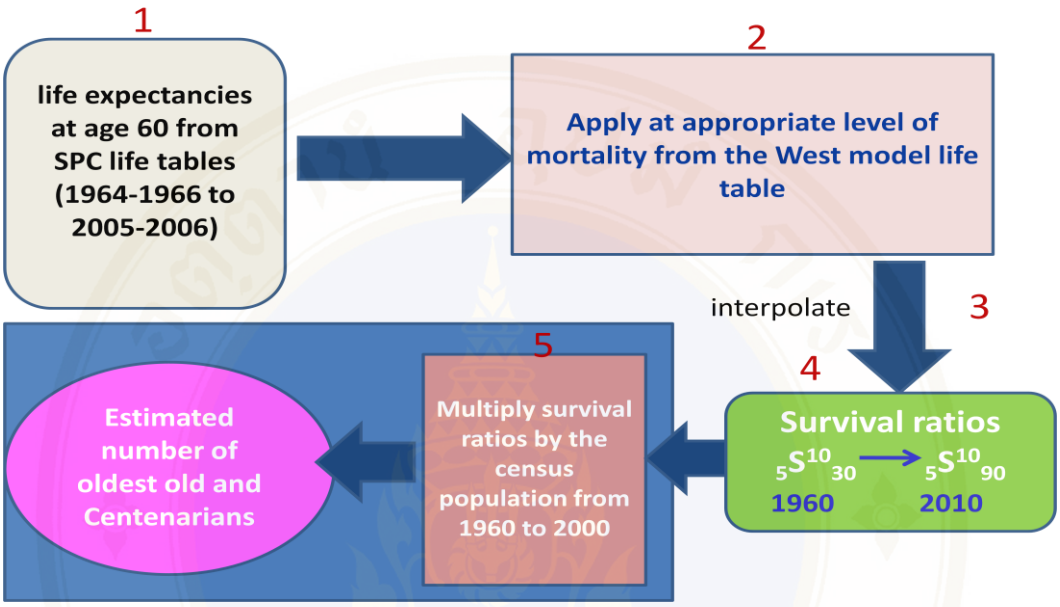

Figure 4.9: The steps of estimating number of centenarians and oldest old

The steps followed to calculate the estimate of the number of centenarians are listed in Table 4.14. According to 2005-2006 SPC life tables, the life expectancy at age 60 for males were 19.41 years, and 21.91 for females. These life expectancies imply that the mortality level of the West model life table was 25-26 for males, and at 24-25 for females. Based on the mortality levels of the West model life table, the mortality level for Thailand was interpolated and found to be at corresponding levels of 25.4 for males and 24.4 for females. At these levels, survival ratios for males and females aged 90 years and over were 0.01747 and 0.02187, respectively. After this step, survival ratios for both sexes were multiplied by the population aged 90 years and over in 2000. The calculation resulted in an estimate of 1,711 centenarians in 2010, with 1,200 (70%) females and 511 (30%) males.

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Table 4.14: Steps followed to calculate the estimate of the number of Thai centenarians in 2010

Steps	Male	Female
1. E_{60} taken from SPC life table during 2005-2006	19.41	21.91
2. Level applied to the West model life table	25-26	24-25
3. Corresponding mortality levels interpolated from the West model life table	25.4	24.4
4. S_{90+} calculated from the corresponding model life table	0.01747	0.02187
5. Number of population aged $_{90+}$ from the 2000 census	29,271	54,845
6. Estimated number of surviving centenarians in 2010 (4)*(5)	511	1,200

The probabilities of surviving for five years by sex are shown in table 4.15. It is indicated that the pattern of surviving were quite smooth. The survival ratios varied inversely with the age; the younger the age, the higher the ratios. Moreover, women were more likely to survive than men in every age interval.

Table 4.15: The probability of surviving based on borrowing survival values from the West model life table

year	1960-1970		1970-1980			1980-1990			1990-2000			2000-2010	
Sx	Male	Female		Male	Female		Male	Female		Male	Female		Male	Female
$_5S^{10}_{30}$	0.9303	0.9861	$_5S^{10}_{40}$	0.9361	0.9614	$_5S^{10}_{50}$	0.8348	0.9173	$_5S^{10}_{60}$	0.8154	0.8800	$_5S^{10}_{70}$	0.5106	0.6042
$_5S^{10}_{35}$	0.9142	0.9789	$_5S^{10}_{45}$	0.9020	0.9416	$_5S^{10}_{55}$	0.7604	0.8691	$_5S^{10}_{65}$	0.7052	0.7916	$_5S^{10}_{75}$	0.3338	0.4101
$_5S^{10}_{40}$	0.8893	0.9674	$_5S^{10}_{50}$	0.8523	0.9107	$_5S^{10}_{60}$	0.6585	0.7881	$_5S^{10}_{70}$	0.5454	0.6463	$_5S^{10}_{80}$	0.1777	0.2227
$_5S^{10}_{45}$	0.8487	0.9502	$_5S^{10}_{55}$	0.7810	0.8590	$_5S^{10}_{65}$	0.5206	0.6585	$_5S^{10}_{75}$	0.3614	0.4523	$_5S^{10}_{85}$	0.0723	0.0911
$_5S^{10}_{50}$	0.7925	0.9233	$_5S^{10}_{60}$	0.6811	0.7737	$_5S^{10}_{70}$	0.3592	0.4866	$_5S^{10}_{80}$	0.1942	0.2539	$_5S^{10}_{90}$	0.0175	0.0219
$_5S^{10}_{55}$	0.7138	0.8782	$_5S^{10}_{65}$	0.5436	0.6407	$_5S^{10}_{75}$	0.2039	0.3027	$_5S^{10}_{85}$	0.0796	0.1071			

Since the cohort survival ratios were obtained, the number of the initial census population for each year was multiplied by the survival ratio to estimate the number of survivors in ten years later. The estimated number of centenarians and oldest old in Thailand are presented in table 4.16.

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Table 4.16: The estimates number of centenarians and oldest old in Thailand

	1970			1980			1990			2000			2010	
Age group	Male	Female	Age group	Male	Female	Age group	Male	Female	Age group	Male	Female	Age group	Male	Female
40-44	823,944	859,086	**50-54**	704,529	727,637	**60-64**	642,992	747,925	**70-74**	572,953	669,325	**80-84**	248,341	358,682
45-49	633,935	666,636	**55-59**	519,697	549,522	**65-69**	406,637	472,031	**75-79**	316,401	401,771	**85-89**	90,846	145,251
50-54	506,664	546,280	**60-64**	378,040	428,874	**70-74**	274,468	348,536	**80-84**	161,740	232,534	**90-94**	24,347	45,318
55-59	419,827	459,611	**65-69**	282,859	328,066	**75-79**	138,640	201,864	**85-89**	63,302	108,171	**95-99**	4,347	9,207
60-64	318,915	371,130	**70-74**	189,797	239,272	**80-84**	74,974	131,570	**90-94**	18,562	36,003	**100+**	511	1,200
65-69	230,018	289,398	**75-79**	106,316	145,923	**85-89**	22,569	46,291	**95-99**	3,061	6,993			

In table 4.16 indicated that females at all age group had always outnumbered males. It causes women can live longer than men, and have greater life expectancy at birth than men. The results showed that the number of young old, median old and oldest old tended to increase over time during the period of 1960 to 2010 as shown more clearly in table 4.16. The comparison of estimated number of elderly age group is shown in table 4.17. It also compared the estimated number at the same age but different cohort. The result showed that the elderly in the later generation can live longer than the young generation. For example, the estimated numbers of young old, age 60-64 year old were 318,915 in 1970, 378,040 in 1980 and 642,992 in 1990 respectively.

Table 4.17: The comparison of estimated number of elderly during 1970-2010

	60-64		70-74		80-84		90-94		100+	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
1970	318,915	371,130								
1980	378,040	428,874	189,797	239,272						
1990	642,992	747,925	274,468	348,536	74,974	131,570				
2000			572,953	669,325	161,740	232,534	18,562	36,003		
2010					248,341	358,682	24,347	45,318	**511**	**1,200**

Using these indirect techniques, it is estimated that there were 1,711 surviving centenarians in 2010, which represents only 12 percent of the 14,493 centenarians recorded in civil registration for the same year. The ratios of estimated

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percentage to reported percentage of the centenarian population were similar for men and women at 9% and 14%, respectively (Table 4.18).

Table 4.18: Comparison of numbers of estimated and registered centenarians

Sexes	Estimated number	Registration number	Absolute difference	%
Total	1,711	14,493	12,782	11.8
Male	511	5,541	5,030	9.2
Female	1,200	8,474	7,274	14.2

In summary, this study used indirect techniques to estimate the number of centenarians and oldest old in Thailand. Four methods are used to estimate mortality based on survival ratios, that is, census survival ratio, life table survival ratio based on Thai model life table, life table survival ratio based on West model life table and life table survival ratio based on UNWPP. To measure the quality of these methods, the survival ratios are used to compare with the levels (based on model life table) of mortality for the same inter-censal intervals.

The result found that life table survival ratios based on West model life table was the most appropriate method than others. It was also found that this method was accurate for both sexes and give smooth pattern. This method showed that mortality levels were improving overtime. However, other methods were found some errors and not smooth pattern. For instance, census survival ratios showed wrong survival ratio (>1) in some ages. The estimates of mortality for old and young age group by calculating survival ratios based on Thailand life table did not appear to be reliable. Similarly, the life table survival ratio based on UNWPP found some inaccuracy for both sexes (low mortality over time, but the tendency of survival ratios was not smooth). After that the life table survival ratio based on West model life table were used to analysis the probabilities of surviving. It was found that the pattern of survival ratios of both sexes was quite similar. The survival ratios varied inversely with the age; the younger the age, the higher the ratios. The survival ratios of female were greater than males in very age group through time. It caused women can live longer than men and have greater life expectancy at birth than male. Besides, elderly in later generation in every age group or those who were surviving in 2000-2010, were

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more likely to survive than elderly in younger generation or those who were surviving in 1960-1970. Moreover, the improved survival of oldest old for both sexes had increased greater than other age group especially improved survival of male.

It was found that there were 1,711 surviving centenarians in 2010. The estimated number of centenarian represents only 12 percent of the 14,493 centenarians recorded in civil registration. These quantitative results prompted questions about the completeness of centenarian data in civil registration. The registration data on centenarians seems to be highly exaggerated.

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CHAPTER V
QUALITY OF CENTENARIAN DATA

This chapter discusses the quality of recorded centenarians in the civil registration of Thailand. First, the quality of data is evaluated quantitatively by reviewing the trend of reported number of centenarians. The proportion of Thai centenarians in the total population is compared with those in other countries. After that the quality of data is assessed by field work in those two provinces, Phetchaburi and Nakhon Pathom, the degree of errors and its explanation discusses. Centenarians in the two provinces from the civil registration are tracked to discover if they are still alive. Reasons for errors in the vital registration system also discuss.

5.1 Trend of centenarians in Thailand

According to the civil registration, the number of Thai centenarians fluctuated from 1994 to 2010. It is reported that there were more than 60,000 living centenarians in 1995 and 1996, which was about 0.10 percent of the total population. After 1996, the number of centenarians dropped shapely to less than 40,000. The number of centenarians stabilized at around 35,000 to 41,000 from 1997 to 2003. During 2004-2008, those numbers fluctuated in the range from 22,000 to 28,000. In 2008, the number dropped to only 13,692 and then rose slightly to 14,493 in 2010.

We could see that the overall trend of recorded Thai centenarians was declining from about 60,000 in 1994 to only 14,000 in 2010. The proportion of centenarians in the total population had been declining from 0.1 to 0.02 percent during this study period (See table 5.1).

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Elderly including centenarians in every country has been increased. However, the trend of recorded Thai centenarians does not appear consistent. It is assumed that the number of Thai centenarians should also be increased over time due to improvement in socio-economic and demographic situation but the trend of recorded Thai centenarians was fluctuated. This inconsistent and decreasing number of centenarians in Thailand made doubt about the exact number of centenarians.

Table 5.1: The number of centenarians in Thailand based on civil registration in 1994-2010

Year	Number of centenarians	Total population	%
1994	58,875	59,095,419	0.10
1995	60,835	59,460,382	0.10
1996	60,842	60,116,182	0.10
1997	37,614	60,816,227	0.06
1998	39,495	61,466,178	0.06
1999	40,933	61,661,701	0.07
2000	39,239	61,878,746	0.06
2001	40,869	62,308,887	0.07
2002	42,715	62,799,872	0.07
2003	34,784	63,079,765	0.06
2004	27,244	61,973,621	0.04
2005	27,460	62,418,054	0.04
2006	28,470	62,828,706	0.05
2007	26,846	63,038,247	0.04
2008	22,462	63,389,730	0.04
2009	13,692	63,525,062	0.02
2010	14,493	63,878,267	0.02

Source: Department of Provincial Administration. (2011).

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5.2 Comparison Thai centenarians with other countries

Table 5.2 presents the comparison of Thai centenarians with other counties to check the quality of Thai centenarians' data. Centenarians comprised only about 0.004 percent of the population in world. It could be indicated that Japan had the highest proportion of centenarians at 0.035 percent. The proportion of centenarians in the 2010, as reported in Thailand civil registration, was much higher than the world average at 0.019 percent. The proportion of Thai centenarians was about 0.023 the same as that of the United States, United Kingdom, Italy, and France and higher than China, Australia, Sweden, and Germany. However, if compare life expectancies of Thai people with the people of above-mentioned countries, it is found that life expectancy of Thais is lower than these countries (PRB 2011). Furthermore, life expectancy also depends on economic development. Based on the level of economic development in Thailand, the proportion of Thai centenarians seemed to be too high. The percentage of Thai centenarians should not be higher or equal to those of the United States, United Kingdom, Australia, Italy, Germany etc. Thus, the finding in chapter 4 that the estimated number of centenarian based on the survival ratio method was much less than that report in the civil registration was confirmed. The number of centenarians in Thailand as reported in the civil registration was clearly an over-estimate.

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Table 5.2: The number of centenarians in some countries reported as of year 2010

Countries	No.of centenarians [1]	No.of total population (per million) [2]	% centenarians of total population	Life expectancy at birth (in years) [2]	GNIPPP per capita [2]
World	292,000	6,987	0.004	70	10,240
USA	70,490	312	0.023	78	45,640
Japan	44,449	128	0.035	83	33,440
UK	12,000	60	0.020	80	35,860
Australia	3,168	23	0.014	82	38,510
Sweden	2,000	94	0.002	82	38,050
Italy	13,000	61	0.021	81	31,870
France	16,000	63	0.025	82	33,950
Germany	12,000	82	0.015	80	36,850
* Thailand	14,493	64	0.023	74	7,640

Source: 1. World Population Prospects, the 2010 Revision

2. Population Reference Bureau, 2011 World Population Data Sheet

***** Ministry of Interior, 2011

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5.3 Centenarians in the study provinces

We received the names of centenarians recorded in the civil registration in 2010 from the office of civil registration, Department of Provincial Administration, Ministry of Interior. These data are as of September 2010. Total number of centenarians recorded in these two provinces was 429 (Nakhon Pathom 351; Phetchaburi 78). All centenarians in these two provinces were followed up by two methods as below:

1) Phone calls

Phone calls were made to the official of Sub-district Administration Organization Officials (S.A.O.), the Tambon headmen, village headmen or community headmen etc. The information about the existing of those centenarian people was asked. The centenarians who still alive were contacted via calling to the official of S.A.O., the Tambon headmen, village headman or community headman etc. to get the way to contact their relatives. After that their relatives were called or visited.

2) Visit and observed

Centenarians who were reported as still alive as inform by the official of S.A.O., the Tambon headmen, village headmen or community headmen etc were contacted and visited. The information about their exact age, birthday, the information of their children, living arrangement, main caregiver, perceived self rated health, functional limitation and daily living activities were collected. Most of respondents were not the centenarians themselves. But there were some cases that the centenarian themselves could give information.

According to follow up these recorded centenarians, it was found that same respondents were counted twice some cases due to different address, and date of birth. The increase of number of centenarians could be occurred when the centenarians were recount. Thus, these double count cases were already deleted from this study.

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5.3.1 Age reported in the registration

The ages of centenarians recorded in registration from two sampled provinces were analyzed. The number of centenarians classified by single age, and age group were showed in figure 5.1 and table 5.3.

The aged of centenarians in civil registration were ranged from 100 to 149 years. There were 39 centenarians aged over 120 years. This was accounted for 9.1 percent of the total recorded centenarians. It should be noted that the people who lived more than 120 years seemed to be implausible. At the present, the oldest living person in the world was 115 years old. There were claims about people aged over 120 years but these claims were not supported by evidence. From the recorded of registration, there were 64 persons aged 110-119 years. This number seemed to be over-reported. The people aged over 110 years who might be called supercentenarians were estimated not more than 1,000 among almost 7 billion world population in the world. The reported number of super-centenarians who aged more than 110 years and over were also displayed by Gerontology research group (2011). It was found that there were estimated to be 300 – 450 living supercentenarians in the world, though only about 80 individual verified living supercentenarians were known. Thus, there might be some errors in these record supercentenarians figure and overstatement of the number of supercentenarians.

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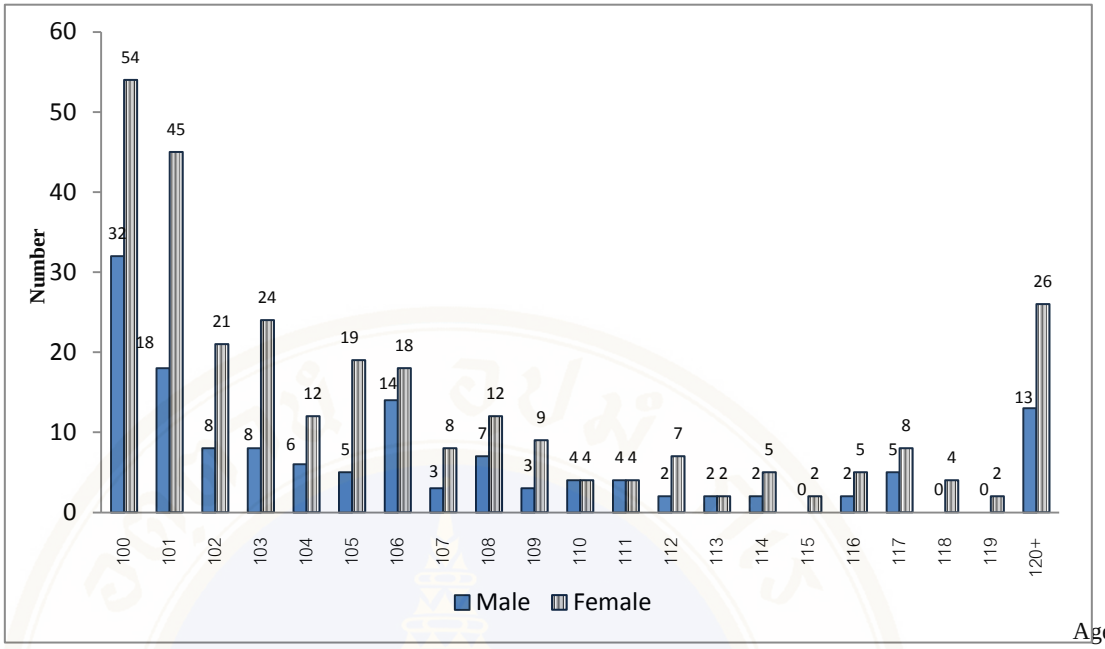

Figure 5.1: Single age of reported centenarians by sex

Table 5.3: Age group of reported centenarians

Age group	%	N
100-104	53.1	228
105-109	22.8	98
110-114	8.4	36
115-119	6.5	28
120 and above	9.1	39
Total	100.0	429

5.3.2 Some characteristics of reported centenarians

1) Sex of reported centenarians

According to the number of recorded centenarians in Thailand, from 14,493 centenarians, the number of males was 71 per 100 females. From 429 centenarians recorded in civil registration in two sample provinces, the number of female was higher than male centenarians. It was accounted that 100 female per 47.5 male centenarians.

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Table 5.4: The characteristics of centenarians by sex

Sex	%	N
Male	32.2	138
Female	67.8	291
Total	100.0	429

However, this sex ratio was very high when compared to the sex ratio of centenarians in the world and other countries such France, Germany, Japan, China, United Kingdom, and United States etc. (United Nations, 2010). The sex ratios of these countries were far lower than recorded centenarians in Thailand (see table 5.5). The sex ratios of many countries were less than 20 male per 100 female centenarians. Thus, the sex ratios of Thai centenarians should be low. It should be noted that the sex ratio of centenarians in Thailand found some errors when compared with many countries.

Table 5.5: The sex ratio of centenarian people from several countries

Countries	Total number of centenarians	male	female	sex ratio
World	292,000	62,000	230,000	27.0
France	16,000	2,000	14,000	14.3
Germany	12,000	2,000	10,000	20.0
Japan	43,000	6,000	37,000	16.2
United Kingdom	13,000	2,000	11,000	18.2
United States	57,000	9,000	48,000	18.8
Thailand (registration data)	14,493	6,019	8,474	71.0
Thailand (from UNWPP)	4,000	1,000	3,000	33.3

Source: Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, *World Population Prospects: The 2010*

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2) Birthday reporting

Birthday reporting of centenarians was examined in this study. All centenarians were born in the time of starting point of birth registration during the later period of King Rama V. The age report in the past was based on a traditional calendar system based on lunar calendar and twelve- year cycle of animal (Knodel & Chayovan, 1991). We can see from this result that more than 81 percent of centenarians had only year of birth in civil registration. Just 19 percent of centenarian data was shown information of complete birthday. However, 15 percent of respondents assumed that their birthday was on the New Year (Table 5.6).

Table 5.6: The characteristics of centenarians by birthday reporting

Birthday reporting	%	N
Only year of birth	81.1	348
D/M/Y	3.5	15
D/M/Y (record New Year Day)	15.4	66
Total	100.0	429

3) Nationality

There were two nationalities of recorded centenarians in this study. Overall, four in five recorded centenarians (78%) belonged to Thai nationality, while remaining about one in four centenarians (22%) belonged to Chinese nationality (Table 5.7).

Table 5.7: The characteristics of centenarians by nationality

Nationality	%	N
Thai	78.1	335
Non-Thai	21.9	94
Total	100.0	429

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4) Residence recorded

The residence of recorded centenarians was classified into three groups. Most of them (87%) lived in their own/relatives house. Only 2% lived in temple. Furthermore, 11 percent of recorded centenarians (47 cases) lived in central house registration. The central house means the house for anyone who cannot be a membership in house registration. It is the registration for unknown persons who their names were in some households but the head of household were not known or disappeared person. Those persons whose address is not known are included in the category of central house (Department of Provincial Administration, 2008). We assumed that these people already died because nobody knew these persons' current status and they were classified as disappeared person (Prasartkul & Chuanwan, 2006). Due to their unknown status in the registration data, these people remain in central house registration because there was no notification that they had died. Thus, the vital registration system included 47 reported centenarians who have died.

Table 5.8: The characteristics of centenarians by type of household

Residence recorded	%	N
House	87.1	374
Temple	1.9	8
Central house	11.0	47
Total	100.0	429

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5.4 Finding

It was found that among the 429 centenarians recorded in civil registration, 368 cases (86%) were deceased while only 61 cases (14%) were still alive. It was also found that among those who were still alive, 43 cases (70%) had ages over 100 years, while the remaining 18 cases (30%) had incorrect ages of less than 100 years, as shown in Figure 5.2

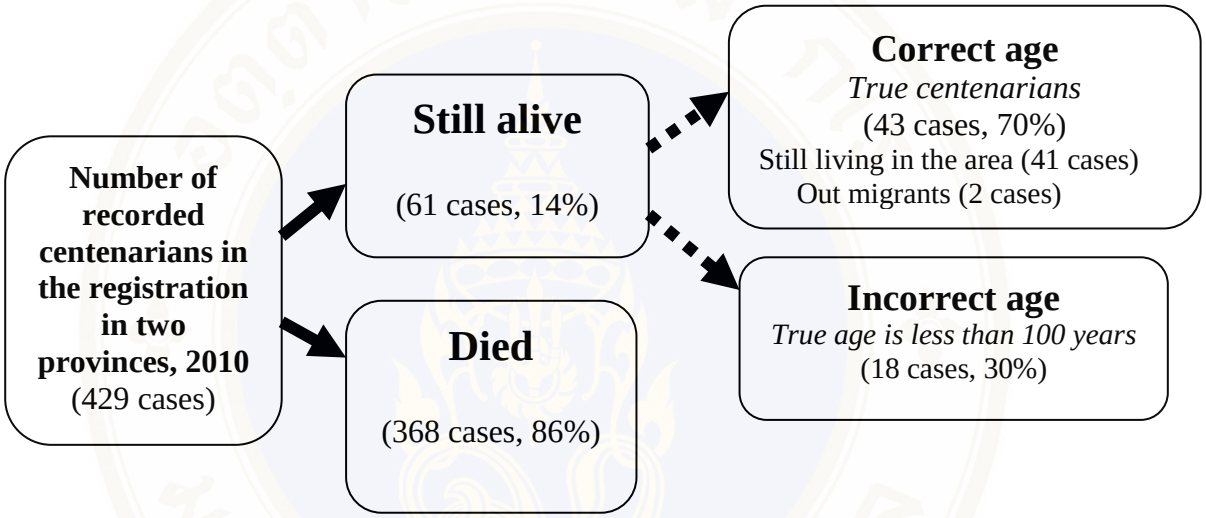

Figure 5.2: Survival status of the population aged 100 years and over reported in civil registration in Nakhon Pathom and Petchaburi provinces, Thailand

5.4.1 Recorded centenarians who already died

Among those centenarians recorded in civil registration, it was found that more than four-fifths of respondents (86%, 368 cases) already died but their death was not recorded in the vital registration database. This finding was confirmed from the official of S.A.O., the Tambon headmen, village headmen or community leader etc. who worked or familiar with these elderly. The officers of S.A.O. had a duty to give the financial aids to these elderly for 500 baht per month. Besides, the Tambon chief, village headmen or community leader who were familiar and usually visit these elderly in that area was also gave this information. They could suppose to check on the existence of those recorded centenarians and about the missing centenarians. They

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informed that most of recorded centenarians died long time ago but their names were still in the registration system.

In addition to this, more than one tenth (11%, 47 cases) individuals were in central house registration. We assumed that they already died because their statuses were unknown and disappeared. Therefore, it should be noted that people whose status live in central house registration were already died.

5.4.2 Recorded centenarians who still alive

Recorded centenarians who still alive were followed by phone calling to the official of S.A.O., the Tambon headmen, village headmen, or community leader etc. They informed that these recorded centenarians were still alive and still live in this area. As mentioned above, among 429 centenarians were found only 61 living cases. It was indicated only 14 percent of centenarians recorded in civil registration. All of the living centenarians were ranged from aged of 100 to 126.

After that all 61 alive centenarians were contacted via calling to the official of S.A.O., the Tambon headmen, village headman or community leader etc. to get the way to contact their relatives to check the exact age of recorded centenarians.

There were only 43 living individuals who were true centenarians, with an age of 100 years or over. These centenarians' ages ranged from 100 to 106. A woman aged 106 years old was the oldest living person in the two sampled provinces at the time of the research. Most centenarians (39 cases) were females, and four were males. The sex ratio was one male per 10 females. Among these 43 centenarians, a majority (31 cases) were 100-102 years old. Only five centenarians were 104 years old or over (Table5.9).

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Table 5.9: The age and sex of true centenarians in two Nakhon Pathom and Petchaburi provinces, Thailand

Sex and age	Number
Sex	
Male	4
Female	39
Total	43
Ratio- Male:Female	**1:10**
Age	
100	12
101	10
102	9
103	7
104	2
105	2
106	1
Total	43

5.4.3 Reasons for exaggerated number of centenarians in the civil registration

It is certain that the number of centenarians recorded in civil registration was exaggerated. The two main reasons for this exaggeration in registration data were found: 1) incompleteness of death registration, and 2) incorrect age.

1) Incompleteness of death registration

A large majority of centenarians recorded in civil registration were already deceased at the time of the study. However, their names were still shown in civil registration records as persons who were still alive. Many reasons for not discharging the names of deceased persons from civil registration were found during the course of this study. These reasons can be grouped into two types: 1) the death was not registered, and 2) the death was registered, but the name of the deceased person had not been discharged from civil registration.

i) The death was not registered

Among those centenarians recorded in civil registration who were deceased, the sub-district or village headmen gave possible reasons why no one

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were not notified about the deaths. They also mentioned that many people think death registration is unnecessary and that there are no benefits gained from registering a death. Some registrars also mentioned that they were familiar with the names of centenarians but had never met those persons.

> *"I heard this name long time ago since I was young, but I have never seen her. I'm sure that she died already."* (Female, Registrar, Nakhon Pathom province)

> *"Relatives of deceased people do not think there is any benefit of death registration. They do not think death registration is necessary"* (Female, Headman of sub-district, Nakhon Pathom province)

Some people did not know how to register a death, especially those living in villages. In addition, if the death occurred outside of the deceased's area of residence, and if people in that area did not know about the death, it would not be recorded.

ii) Death already registered but the names of deceased person had not been discharged from the civil registration

Cases of registered deaths in which names were not deleted from civil registration were found. Some deaths were registered but the name of the deceased still appeared in registration records. Possible reasons for this occurrence include incomplete registration by relatives of the deceased person due to complication process including the requirement of many documents or the inconvenience of going to the registration office.

In cases where death occurs outside the deceased's municipal area, the village headmen of the area where the person has died are responsible for notifying registrars of the death. It was found some village headmen had informed registrars about deaths in the areas for which they were responsible but the names were still

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shown in the list of voters. This may be because the headmen did not submit complete documents such as a death certificate or other evidence when notifying the registrars.

> *"I told the registrar many times that these people already died. But the registrar needs their death certificates. I didn't have them. It is difficult to get those documents because their relatives have not lived here for a long time and (these people) died outside this area"* (Male, Village headman, Phetchaburi province)

This study also explored reasons for the names of dead persons were not discharged from civil registration. Most registrars reported that they could not discharge names without death certification because they were not sure whether or not those persons were in fact deceased. It was observed that even if a registrar personally knew about the death of a person he/ she could not discharge the name from registration without having complete legal documents. As one registrar mentioned:

> *"I could not delete these names from registration. I didn't know those persons already died or not. The death certification was the first document to show the evidence."* (Female, Registrar, Nakhon Pathom province)

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2) Incorrect age

Another reason identified during this study for an exaggerated number of centenarians in civil registration was incorrect age in civil registration. Among the 61 surviving centenarians who were recorded, 18 cases were found in which an incorrect age of less than 100 years old was recorded.

It was also found that out of 429 recorded centenarians in civil registration in the studied provinces, 284 persons had a recorded age of 106 years and over. However, this study found that there were no living persons aged over 106 years. This indicates that the ages of all recorded centenarians of greater than 106 years were incorrect as shown in table 5.10.

Table 5.10: Age reporting of centenarians reported from civil registration by single age

Age	Age correct		Total
	Correct	Not correct	
100	12	2	14
101	10	2	12
102	9	1	10
103	7	3	10
104	3	1	4
105	1	2	3
106	1	3	4
108	0	1	1
109	0	1	1
110	0	1	1
126	0	1	1
Total	43	18	61

The study found many reasons for incorrect reporting of age. Among these reasons were the tendency to over report age by one cycle of animal years (12 years), other errors in counting age, and errors in data entry such as miskeyed or miscoded ages.

The traditional way of reporting dates of birth in Thailand is based on the lunar calendar and a twelve-year cycle in which each year is assigned an animal. This traditional calendar system would have been commonly used to record the dates of birth of people who were born approximately one hundred years ago (Knodel &

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Chayovan, 1991). When the civil registration system was computerized in the 1980s**,** birth dates recorded using the traditional calendar system of animal years and lunar months were converted to solar calendar years (in Christian Era (A.D.) or Buddhist Era (B.E.)). During this conversion process mistakes in age recording could have easily occurred.

The exact ages of some individuals in this study were lower than the age recorded in registration data by about one cycle. This may be due to confusion between the twelve-year cycles of animal years and Western calendar years when the registration process was computerized during the 1980s. For example, one recorded centenarian woman was born in the year of the monkey, so in the year 2010 her age was recorded as 101 years old. However, her exact age was only 89 years, reflecting an error of 12 years. Four cases out of a total of 61 were found to have true ages 12 years less than those recorded.

> *"I'm 92 years old now. I was born in year of the snake. I'm not a hundred years old yet. My age was incorrect a long time ago. My ID card shows I was born in 2438 B.E."* (Female, 105 years old recorded in registration data, Phetchaburi province)

Another reason for incorrect recording of age found in the study is that many Thai people report their age as their going-on year. Traditionally, it is quite common for the elderly to report their "going to" age, in other words, the year that they will be on their next birthday (Chamratrithirong et al., 1978; Knodel & Chayovan, 1991). It was also found during the course of the study that one person of Chinese origin reported her age as counted from one year before she born. In Chinese culture age is counted from the time that the mother becomes pregnant (Yi, 2008). In this manner of reporting, a baby is already one year old when it is born. This tradition might affect the reporting of age among Thai people with a Chinese heritage.

In some cases, years of birth of centenarians was wrongly recorded. It could be due to errors in data entry, either miskeying or miscoding of age. The errors in data entry could have occurred when the registrars entered the dates of birth into the registration system. The son of a recorded centenarian mentioned:

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"My father was born in B.E. 2472 or now he is only 81 years old, but on his ID card it shows a birth date of B.E. 2427 which means he would be 126 years" (Male, Son of a centenarian in registration data, Phetchaburi province)

It was found that some individuals were aware their age was reported incorrectly in civil registration data. Some said that they had already informed officials about the mistakes but nothing had been corrected.

"I reported the incorrect age of my father to the registrar a year ago, but they did not correct his age in the registration information" (Female, Daughter of a centenarian, Nakhon Pathom province)

Most relatives of recorded centenarians knew their exact ages but did not attempt to correct it in civil registration. The reason they gave for this was that they did not have a problem with the incorrect age being recorded. Some relatives of respondents realized age of their respondents and proved exact by comparing with anyone who was in the same generation with their parents or grandparent.

"I know my mother is not 100 years old yet, but we have no problem the wrong age being recorded. We know exact age of my mother. She is just 84 years old but if they recorded my mother's age as 103, there's no problem in our life" (Female, Daughter of a woman with a recorded age 103 years, Phetchaburi province)

"Even I knew my mother was not a centenarian, but we have never been in a trouble. We knew exact age of my mother. Being a centenarian was not effect at all". (Female, Daughter of recorded centenarian, Phetchaburi)
"I know my mother age was just 90 years. We checked her age with oldest person who stayed here long time ago and she was in the same cohort with my mother."(Female, Daughter of recorded centenarian, Nakhon Pathom)

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However, some respondents answered that they would like to inform the mistake of age reporting of their parents but they do not know how to notify. Besides, they did not have time to go to the registration office. Thus, their age misreporting was still shown in the registration.

> *"I would like to correct my mother's age but I don't know how to inform and whom to inform". (Male, Son of recorded centenarian, Nakhon Pathom)*

Age of centenarians tend to have some errors due to the change of registration system. The computerize registration may effect to age misreporting due to most of them reported age higher than exact age a twelve-year cycle of animal years and inaccuracy in the process of data entry. Other study also found that age exaggeration is common at advance ages especially centenarians and lead to underestimates of mortality at the oldest ages (Preston et al., 1999).

The finding suggested the improved quality of civil registration in Thailand as many studies found a certain degree of incompleteness of the death registration that needed further improvement (Hill, et al., 2007; Prasartkul & Vapattanawong, 2006; Preston & Hill, 1980; Rukumnuaykit, 2006; Saito et al., 2012; Tangcharoensathien, et al., 2006; Vapattanawong & Prasartkul, 2011). If the death registration was incomplete, the number of surviving centenarians was likely to be affected.

Furthermore, Khodel and Chayovan (1991) and Chamratrithirong, Debavalya, and Khodel (1978) had studied age and birth data reporting in Thailand. Studies showed that age data on civil registration are more likely to be affected on age misreporting. It can be seen that almost all Thais know their year of birth but some Thais has reported age as the Thai tradition to report the "going to age" (yang) or to report age at next birthday. This error leads to incompleteness of age data on civil registration and census. Preston and Hill (1980) estimated the completeness of death registration in Thailand. These studied also found that the data on civil registration in Thailand were found with inaccuracies and errors. Similarly, the study of Luther and Dhanasakdi and (1986) who studied the consistent correction of census and vital

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registration data for Thailand, 1960-80 and found that the age exaggeration at the oldest ages is indicated and concerned both in census and vital registration. Thus, the exaggeration of information about centenarians as found in this study reflects the quality of registration data, especially on the oldest population.

5.4.4 The socio-demographic characteristics of centenarians

Among 429 centenarians recorded in civil registration, we found only 43 exact centenarians and had correct age. Out of 43 centenarians, 2 centenarians were migrated to another province. Thus, the detail information about health of 41 centenarians was presented.

The socio-demographic characteristics of centenarians was collected from some centenarians themselves and their relatives or caregivers via called phone, visited and observed some cases. The socio-demographic characteristics of centenarians included living arrangement, main caregiver, perceived self rated health, functional limitation, and daily living activities.

Table 5.11 showed that 30 centenarians lived with their children, sibling and other. Observably, 3 centenarians lived alone but their sibling or children still lived nearby and stayed overnight with them. However, nearly 25 centenarians was daughter of centenarians who were main caregivers.

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Table 5.11: The socio-demographic characteristics of centenarians

Socio-demographic characteristics	Number
Living arrangements	
Alone	3
With only children	8
With children sibling and others	30
Main caregivers	
Daughter	25
Son	6
Cousin	8
Son in law	2
Perceived health status of centenarians	
Good	26
Fair	6
Poor	9
The functional limitation	
Eyesight	
Good	21
Fair	17
Poor	3
Hearing	
Good	15
Fair	24
Poor	2
Memory	
Good	23
Fair	14
Poor	4
Activity of Daily Living (ADL)	
Eating	
Without assistant	27
with assistant	5
Cannot perform	9
Putting on clothes	
Without assistant	22
with assistant	6
Cannot perform	13
Bathing	
Without assistant	2
with assistant	7
Cannot perform	14
Toileting	
Without assistant	17
with assistant	9
Cannot perform	15

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Table 5.11: The socio-demographic characteristics of centenarians (cont.)

Socio-demographic characteristics	Number
Transferring	
Without assistant	21
with assistant	6
Cannot perform	14
Total	**41**

Perceived health status of centenarians was an individual's own assessment of their health (Stathakos et al., 2005). Centenarians or their primary caregivers were asked about their perception on health status of centenarians. The responses were categories into three groups, namely good, neither good nor bad, and poor. It was found that the majority of centenarians (26 cases) seemed to perceived centenarian's health as good. A few centenarians perceived as fair (6 cases) and poor (9 cases).

The functional limitation was defined as the function of physical actions of centenarians. Centenarians or the primary caregivers of centenarians were asked to assess the functioning of centenarians. The functional limitation in this study referred eyesight, hearing and memory. All centenarians or caregivers were asked their physical actions of centenarians as good, fair and poor. It was notable that majority of centenarians had good eyesight (21 cases), and memory (23 cases). However, only 15 cases had good hearing. On the other hand, 24 cases reported that their hearing capacity was fair. Similarly 17 cases and 14 cases had fair eyesight and memory respectively.

Activity of Daily Living (ADL) was a daily self-cares activity. This study measured five activities of ADL namely, eating, putting on clothes, bathing, toileting and transferring (sitting/ walking). All centenarians or primary caregivers of centenarians were asked the above mentioned activities. The responses were categorized into three categories (without assistant, with assistant, and cannot perform at all). It was encouraging to note that more than half of centenarians could eat (27 cases), put on clothes (22 cases), and transfer by sit or walk (21 cases) without assistant. On the other hand, more than one out of three centenarians could not transfer

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sit/walk (14 cases), toileting (15 cases), bathing (14 cases) and putting on clothes (13 cases).

In summary, centenarians recorded in two sample provinces were followed up to support the quantitative result. It was found that among 429 centenarians recorded in civil registration; only 61 cases were still alive. More than 80 percent of recorded centenarians (368 cases) already died. 61 alive recorded centenarians were checked the accuracy of age reporting. There were only 43 cases or only 10 percent were found to be true centenarians, with an age of 100 years and over. The ages of certain centenarians of two sample provinces were ranged from 100 to 105 years. It seems that the ages of recorded centenarians over 106 years were found to be incorrectly recorded. In regard to health status of centenarians, it is found that more than half of them are still healthy. It can be concluded that there is a selectivity of being a centenarian. These who can live up to 100 years are those who are selected by nature or behaviors.

According to qualitative result, it is certain that the number of centenarians recorded in civil registration was exaggerated. The two main reasons for exaggerated number of centenarians in civil registration data were found two reasons 1) incompleteness of death registration, and 2) incorrect age. The incompleteness of death registration has been found due to the death was not registered and the death was registered, but the name of the deceased person had not been discharged from civil registration. The incorrect age will be occurred due to centenarians tendency to over report age by one cycle of animal years (12 years) and confusion for the registration process during computerized in the 1980s. In addition to this, the errors in data entry by miscoded and miskeyed of age were found. Reported age as going on year or Chinese people reported age as counted from one year before they born were one of the reasons of age misreporting. Thus, the finding of qualitative study found incompleteness of civil registration. The improvement of civil registration system is needed for cleaning up data recording.

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CHAPTER VI
CONCLUSION AND RECOMMENDATION

The aims of this study were to estimate the number of centenarians in Thailand and the survival pattern among centenarians and the oldest old in Thailand. In addition, the quality of centenarian data in civil registration was evaluated to explain the reasons for incompleteness of registration data. Quantitative and qualitative analysis were used in this study.

For quantitative analysis, we relied on data from several sources, namely the series of census data from the 1960-2000, the Survey of Population Change (SPC) for several periods from 1964-1966 to 2005-2006, the Coale and Demeny regional model life tables, and United Nations World Population Prospects (UN WPP). These data were used to calculate the survival ratios, which could be compared to measure of mortality from model life tables. The best method was selected to estimate the number of centenarians and oldest old in Thailand and to estimate survival pattern among centenarians and oldest old in Thailand.

The recorded data of centenarians from two sample provinces, Nakhon Pathom and Petchaburi provinces, in the civil registration recorded in September 2010 were selected to collect the detail information for qualitative analysis. The individual records of these centenarians in two provinces were followed up to verify the quality of registration data.

6.1 Conclusion

According to estimation of survival probabilities, two methods based on census survival ratio, and life table survival ratios from three different sources of data were used. The survivorship ratios from the West model life tables were the best method to estimate the number of centenarians and oldest old in Thailand. It was

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found that the patterns of survival ratios of both sexes at old age were quite similar. The survival ratios varied inversely with the age; the younger the age, the higher the ratios. However, the probability of surviving of both sexes was improved. It was shown that the survival ratios were increased sharply in every period especially between the period of 1980 to 1990 and 1990 to 2000. It was probably due to the effect of the HIV epidemic in the 1980s and 1990s, with a major influence in males and a slowing effect in females (Hill, et al., 2007). Furthermore, the survival ratios of females were greater than males in every age interval. It could be explained by the highest gains in female life expectancy at birth and higher longevity. The patterns of survival ratios of both sexes at younger age varied inversely with old age. The probability of surviving of both sexes improved over time. It indicated that elderly were likely to increase in the future.

To investigate the improved survival among Thai elderly by generation were classified by birth cohorts into three age groups, young old (60-69 years), middle old (70-79 years) and oldest old (80 years and over). It was found that the survival ratios in every age group of both sexes were increasing during the period of 1960-2010. Elderly in the later generation (1990-2000) had higher survival rates compared to the old generation (1960-1970). Additionally, the survival ratios varied inversely by age that meant the younger, the higher ratios of survival. The survival ratios of females were greater than the rates of males in every age group through time, while the increase rate of survival ratios among male were higher than that of females in every age group. Finally, compared to the survival ratios in other elderly age group, the ratio of elderly aged 80 and over, the oldest old, increased greatest. Therefore, this could be concluded that people live longer.

After survival differentials among Thai elderly were analyzed, it was found that the number of female elderly at all age group had always outnumbered males. It caused women could live longer than men and had greater life expectancy at birth than men. Besides, the number of young old, median old and oldest old had increased over time during the period of 1960 to 2010. When compared the estimated number at the same age but different cohort, it was found that elderly in the later generation could live longer than the young generation.

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The results of this study showed that the number of centenarians recorded in civil registration was over reported. It was estimated that there were 1,711 centenarians in Thailand in 2010, which represents only 12% of the centenarians actually recorded in civil registration.

All centenarians recorded in civil registration in the two provinces included in the sample group were followed in order to explain the reasons for incorrectness of the registration data. Among 429 recorded centenarians, only 43 cases (10%) were found to be true centenarians. Among the remaining 90% of recorded centenarians, most had already died and some were found to have ages of less than 100 years. The ages of all centenarians over 106 years were found to be incorrectly recorded and were over reported in all cases.

Two important causes of the inconsistencies occurring in centenarian data were incompleteness of death registration and incorrect age recording. Many reasons were found for the incompleteness of death registration such as non-registered deaths and failure to delete the names of the deceased from registration data. Failure to notify the appropriate officials of a death was found to be the main reason for not discharging the names of deceased persons from registration data. The name of a deceased person cannot be deleted from the register if the death certificate is not provided to the registrar. The process of death notification is inflexible and the multiple steps required prevent the deletion of deceased people from registration records. The results of this study were similar to the findings of a study conducted by Prasartkul and Vapattanawong (2006) in Kanchanaburi which found the requirement of multiple steps in the death registration process as the main cause of inconsistencies in registration information. This study also found that most people completed the first step of death of registration (reporting the death to the village headman or a police officer, or receiving a death certificate from the hospital) but did not report the death to registrars at the district or municipality office.

Another important reason for an exaggerated number of centenarians in civil registration was incorrect recording of age. Age mis-recording could be due to mistake in counting age and errors during data entry such mis-keying or miscoding age. These errors may lead to the mis-recording of age in registration data.

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Furthermore, most of exact centenarians lived in extend/joint family. Only few centenarians lived alone and were self sufficient in most ADL. However, these centenarians were not a burden of nation because their children/ relatives stayed nearby and always come to stay overnight. They also had caregivers especially their daughters were the main caregivers of them. It should be noted that all centenarians had a good family relations. Thus, it maybe leads to centenarians had a good emotional support and had a positive attitude to life.

Besides, the result also found that most centenarians were still healthy. There were just few centenarians who had high age had illness and could not do any daily activities. Most centenarians or their relatives perceived health as good eyesight, hearing and memory. Besides, majority of centenarians could do daily activities namely eating, putting on clothes, bathing, toileting and transferring (sitting/ walking) by themselves. It could be explained that people who reach the age of 100 displayed a healthy aging with delay of diseases and disabilities until very late in life (Willcox et al., 2008). This elderly group also represented as a select group (Buono et al., 1998). The centenarians might be had biologically better fit with preserved adaptability (Andersen-Ranberg et al., 2001). Furthermore, they were a valuable resource for the study of successful ageing (Perls et al., 1999). Thus, it was indicated that there was a selectivity of being a centenarian. Most centenarians were still found healthy and longer life.

6.2 Policy recommendations

6.2.1 To improve registration data

1) The exaggeration of number of centenarians as found in this study reflects the quality of registration data, especially on the oldest population. Since population data from registration are officially used as the base for several activities such as to arrange the electoral zoning, and to allocate government budget and welfare resources, its accuracy is very meaningful. The finding of this study suggests many points to improve the quality of registration data. The deletion of deceased persons'

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names by less complicated procedure is one among others. The correction of birth date should also be done.

2) Age misreporting of some centenarians was found in this study. The civil registration should have channels to solve age misstatement of centenarians. Thus, the assistances from any institutes and governments are need such as Ministry of Interior, Ministry of Social Development and Human Security, the administration of Tambol, headship of Tambol and village etc.

6.2.2 To improve quality of life of centenarians

1) While the Thai society has been ageing very rapidly, many programs concerning the elderly's quality of life are being purposed. The programs such as special welfare and value raising campaign for elderly and centenarians are recommended. In performing such programs efficiently, the accurate data are needed. In Thailand, the civil registration is still the main source of population data. Thus, the improvement of registration system will certainly benefit to government and the Thai people.

2) To give more respect or value to the Thai elderly, Thai government may organize elderly campaign. For example, government may provide some supports to the centenarians such as health care welfare, social welfare, and housing welfare etc. It is due to centenarians are a special age group. All of these policies maybe support centenarians in terms of physical, mind, economic and social aspects. Moreover, government may celebrate or provide award when elderly reach 100 years by setting one day in a year for centenarians such as in Songkran Day or Elderly Day.

3) The policy on strengthening Thai family is needed as security for all elder. When any persons get old, family should be the first level of institution taking responsible to look after them.

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6.3 Recommendations for the next research

1) There are many indirect technique methods that can be used for estimating the number of centenarians and oldest old. The more appropriate method may be found and challenge if we estimate number of centenarians by other indirect methods.

2) In this study, qualitative study was conducted only in two sample provinces. The finding would be more interesting and more reliable if it was representative in quantitative nature and conducted in more than two provinces or covered all centenarians in Thailand.

3) This study could be the guideline to those who want to study further about elderly by using registration data.

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REFERENCES

Andersen-Ranberg, K., Schroll, M., & Jeune, B. (2001). Healthy Centenarians Do Not Exist, but Autonomous Centenarians Do: A Population-Based Study of Morbidity Among Danish Centenarians. *JAGS 49*, 900-908.

Balavi Natural Health Center. (2004). Thai Centenarian Club. Retrieved 5 April, 2006, from http://www.balavi.com/100years/22-07-47/Healthy%20Aging.asp

Bundhamcharoen, K., Odton, P., Phulkerd, S., & Tangcharoensathien, V. (2011). Burden of disease in Thailand: changes in health gap between 1999 and 2004. *BMC Public Health, 11*(1), 53.

Buono, M. D., Urciuoli, O., & Leo, D. D. (1998). Quality of life and longevity: a study of centenarians. *Age and Ageing, 27*, 207-216.

Chamratrithirong, A., Debavalya, N., & Knodel, J. (1978). *Age reporting in Thailand : Age at last birthday versus age at next birthday* (Vol. 25): Institute of Population Studies, Chulalongkorn University.

Coale, A., & Demeny, P. (1966). *Regional model life tables and stable populations* Princeton University

Coale, A., & Demeny, P. (1983). *With B.Vaughan. Reginal model life table and stable populations*. New York: Academic Press.

Coale, A., & Guo, G. (1989). Revised Regional Model Life Tables at Very Low Levels of Mortality. *Population Index, 55*(4), 613-643.

Coale, A. J. (1985). Estimating the Expectation of Life at Old Ages: Comments on the Article by Mitra. *Population Studies, 39*(3), 507-509.

Coale, A. J., & Ellen Eliason, K. (1986). Mortality Crossovers: Reality or Bad Data? *Population Studies, 40*(3), 389-401.

Daley, W. M., Mallett, R. L., Shapir, R. J., & Prewitt, K. (1990). *Centenarians in the United States 1990*. Washington, DC: U.S. Census Bureau.

Copyright by Mahidol University

Department of Provincial Administration. (2008). About central house Retrieved 24 May, 2011, from http://www.kroobannok.com/1153

Department of Provincial Administration. (2011). Number of population Retrieved 15 January 2012, from http://stat.bora.dopa.go.th/cgi-bin/people2_stat.exe?YEAR=53&LEVEL=4&PROVINCE=00%23no&DISTRICT=&TAMBON=

DOPA. (1999). *Manual of practicing on population registration 1999*: Department of Provincial Administration, Ministry of Interior (in Thai).

Dublin, L. I., & Lotka, A. J. (1949). *Length of Life*. New York: Ronald Press.

Finch, C. E. (2008). The human life span: Present, past, and future *The biology of human longevity: Inflammation, nutrition, and aging in the evolution of life spans* (pp. 374): Elsevier.

Fulton, J. P. (1979). Evaluation of Selected Aspects of the 1970 Census of Thailand. . 29-79.

Garson, L. K. (1991). The Centenarian Question: Old-Age Mortality in the Soviet Union, 1897 to 1970. *Population Studies, 45*(2), 265-278.

Gavrilova, N. S., & Gavrilov, L. A. (2011). *Old-Age Mortality Measurement and Modeling*. Paper presented at the The 2011 Annual Meeting of the Population Association of America. Retrieved from http://paa2011.princeton.edu/download.aspx?submissionId=112428

Gerontology Research Group. (2011). Validated Living Supercentenarians. Retrieved 19 February 2011, from http://www.grg.org/Adams/E.HTM

Gomes, M. M. F., & Turra, C. M. (2009). The number of centenarians in Brazil: Indirect estimates based on death certificates. *Demographic Research, 20*(20), 495-502.

Greenwood, M., & Irwin, J. O. (1939). The biostatistics of senility. *Human Biology, 11*(1-23).

Guinness World Records Corporate. (2012). World's oldest living person besse cooper turns 115. from http://www.guinnessworldrecords.com/news/world%E2%80%99s-oldest-living-person-besse-cooper-turns-115/

Copyright by Mahidol University

Hill, K., Vapattanawong, P., Prasartkul, P., Porapakkham, Y., Lim, S. S., & Lopez, A. D. (2007). Epidemiologic transition interrupted: A reassessment of mortality trends in Thailand, 1980–2000. *Int. J. Epidemiol, 36*, 374-384.

Hirschman, C., Tan, J., Chamratrithirong, A., & Guest, P. (1994). The Path to Below Replacement-Level Fertility in Thailand. *International Family Planning Perspectives, 20*(3), 82-107.

INED. (2011). Glossary. Retrieved 12 May, 2011, from http://www.ined.fr/

IPSR. (2004). *Glossary of terms in popular and social research*. Nakhon Pathom: Institute for Population and Social Research.

IPSR. (2010). Thai Centenarian Center. Retrieved 15 March, 2010, from http://www.thaicentenarian.mahidol.ac.th/TECIC/

IPSR. (2011). *Mahidol Population Gazette* (Vol. 20). Nakhon Pathom: Institute for Population and Social Research.

Knodel, J., & Chamratrithirong, A. (1978). *Infant and child mortality in Thailand: levels, trends, and differentials as derived through indirect estimation techniques*: East-West Population Institute.

Knodel, J., & Chayovan, N. (1991). Age and birth date reporting in Thailand. *Asia-Pacific Population Journal, 5*, 91-215.

Lundberg, M., & Lam, D. (2007). *Harnessing the Demographic Dividend: Lessons From the World Development Report 2007*: Wilson Center.

Luther, N. Y., & Dhanasakdi, N. (1986). *Consistent correction of census and vital registration data for Thailand, 1960-80*. Honolulu, Hawaii: East-West Population Institute, East-West Center

Ministry of Interior. (1991). *Act of civil registration*

National Statistical Office. (1962). *The 1960 population and housing census*. Bangkok: National Statistical Office.

National Statistical Office. (2002). *The 2000 population and housing census*. Bangkok: National Statistical Office.

National Statistical Office. (2008). *Report on the 2005-2006 Survey of Population Change*. Bangkok: National Statistic Office.

National Statistical Office. (2011). *Executive summary of census 2010 (Preliminary Report) in Thai*. Bangkok: National Statistical Office.

Copyright by Mahidol University

Pejaranonda, C., Arnold, F., & Hauser, P. M. (1983). *Revised estimates of the 1980 population of Thailand*: National Statistical Office.

Perls, T. T., Bochen, K., Freeman, M., Alpert, L., & Silver, M. H. (1999). Validity of reported age and centenarian prevalence in New England. *Age and Ageing, 28*, 193-197.

Population Reference Bureau. (2011). *2011 World Population Data Sheet*. Washington DC, USA.

Prasartkul, P., & Chuanwan, S. (2006). *Utilization of civil registration data to study demography of centenarians.* Paper presented at the The 2006 Thai National Symposium on Population Studies, Bangkok.

Prasartkul, P., & Rakchanyaban, U. (2002). *Estimated Generation Life Tables for Thailand of Five-Year Birth Cohorts : 1900-2000*: IPSR Publication.

Prasartkul, P., & Vapattanawong, P. (2005). The situation of Thai Population in 2005. In K. Archavanitkul & P. Prasartkul (Eds.), *Population and Social: Population of Thailand on 2005*. Royal River, Bangkok: Institute for Population and Social Research.

Prasartkul, P., & Vapattanawong, P. (2006). The completeness of death registration in Thailand: Evidence from demographic surveillance system of the Kanchanaburi Project. In K. Archavanitkul (Ed.), *World Health&Population* (Vol. 8, pp. 43-51).

Prasartkul, P., & Vapattanawong, P. (2011). Transitional point of the Thai population. In S. Punpuing & M. Sunpuwan (Eds.), *Population and Social 2011: Thailand's Population in Transition: A Turning Point for Thai Society* (pp. 13-22): Presented in Miracle Hotel, Bankok.

Preston, S., & Hill, K. (1980). Estimating the completeness of death registration. *Population Studies, 34*(2), 349-366.

Preston, S. H., Elo, I. T., & Stewart, Q. (1999). Effects of Age Misreporting on Mortality Estimates at Older Ages. *Population Studies, 53*(2), 165-177.

Robine, J. M., & Saito, Y. (2003). Survival beyond age 100: The case of Japan. *Population and Development Review, 29*, 208-228.

Rowland, D. T. (2006). *Demographic methods and concepts*. New York: Oxford University Press Inc.

Copyright by Mahidol University

Rukumnuaykit, P. (2006). Mortality and causes of death in Thailand: Evidence from the survey of population change and death registration. *Asia-Pacific Population Journal, 21*(2), 67-84.

Saito, Y., Yong, V., & Robine, J.-M. (2012). The mystery of Japan's missing centenarians explained. *Demographic Research, 26*(11), 239-252.

Siegel, J. S., & Passel, J. S. (1976). New Estimates of the Number of Centenarians in the United States. *Journal of the American Statistical Association, 71*(355), 559-566.

Siegel, J. S., Swanson, D., & Shryock, H. S. (2004). *The methods and materials of demography*: Elsevier Academic Press.

Stathakos, D., Pratsinis, H., Zachos, I., Vlahaki, I., Gianakopoulou, A., Zianni, D., et al. (2005). Greek centenarians: assessment of functional health status and life-style characteristics. *Exp Gerontol, 40*(6), 512-518.

Stloukal, L. (2004). Rural population ageing in developing countries: issues for consideration by FAO. Retrieved 24 December, 2008, from http://www.fao.org/sd/dim_pe3/pe3_040401_en.htm

Tangcharoensathien, V., Faramnuayphol, P., Teokul, W., Bundhamcharoen, K., & Wibulpholprasert, S. (2006). A critical assessment of mortality Statistics in Thailand: Potential for improvements. *Bulletin of the World Health Organization 84*, 233-238.

Thatcher, R. (2001). The demographic of centenarians in England and Wales. *Population Annee, 13*(1), 139-156.

The Hindu. (2011). Number of centenarians in Japan tops 47,000. Retrieved from http://www.thehindu.com/news/international/article2450024.ece

The University of Georgia. (2005). The Georgia Centenarian Study: A Study of Longevity and Survival of the Oldest Old, 1988 - 2007. Retrieved 15 Febuary, 2010, from http://www.publichealth.uga.edu/geron/sites/default/files/documents/publications/CentStudyBooklet.pdf

United Nations. (1983). *Manual X: Indirect Techniques for Demographic Estimation* New York United Nations.

Copyright by Mahidol University

United Nations. (2002). *Methods for estimating adult mortality* United States: New York.

United Nations. (2002). *World Population Ageing: 1950-2050*. New York

United Nations. (2006). A network for health. *Ageing and Development In Latin America and the Caribbean*. Retrieved from http://www.eclac.cl/celade/noticias/documentosdetrabajo/4/36644/boletin_envejecimiento3i.pdf

United Nations. (2010). World Population Prospects, the 2010 Revision. Retrieved 12 March 2011, from http://esa.un.org/wpp/Excel-Data/population.htm

United Nations. (2011). International Day of Older Persons. Retrieved 22 September, 2011, from http://www.un.org/en/events/olderpersonsday/

Vapattanawong, P. (2002). *SURVIVAL DIFFERENTIALS AMONG THE THAI ELDERLY, 1964 - 2000*. Mahidol University, Nakhon Pathom.

Vapattanawong, P., Hogan, M. C., Hanvoravongchai, P., Gakidou, E., Vos, T., Lopez, A. D., et al. (2007). Reductions in child mortality levels and inequalities in Thailand: analysis of two censuses. *The Lancet, 369*(9564), 850-855.

Vapattanawong, P., & Prasartkul, P. (2009). Current mortality patterns of Thai older persons. *Journal of Population, 1*(1), 5-19. (in Thai).

Vapattanawong, P., & Prasartkul, P. (2011). Under-registration of deaths in Thailand in 2005–2006: results of cross-matching data from two sources. *Bulletin of the World Health Organization, 89*, 806-812.

Vaupel, W. J. (1998). Demographic analysis of aging and longevity. *The American Economic Review, 88*(2), 242-247.

Vaupel, W. J. (2001). Demographic insight into longevity. *Population: An English Selection, 13*(1), 245-259.

Werne, C. A. (2010). *The Older Population: 2010*: United States Census Bureau.

Willcox, D., BJ, W., He, Q., Rosenbaum, M., & Suzuki, M. (2008). Life at the extreme limit: Phenotypic characteristics of supercentenarians in Okinawa. . *Journal of Gerontology: MEDICAL SCIENCES, 63(A)*(11), 1201-1208.

World Health Organization. (2012). Life expectancy. Retrieved 16 April 2012, from http://www.who.int/topics/life_expectancy/en/

Copyright by Mahidol University

Yi, Z. (2008). Reliability of age reporting among the Chinese oldest old in the CLHLS datasets. In D. L. P. Y.Zeng, D. A. Vlosky & D. Gu. (Eds.), *Healthy longevity in China: Demographic, socionomic, and psychological dimensions* (pp. 61-78). The Netherlands: Springer.

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