Variations in Health Status of the Elderly in Thailand

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The candidate confirms that the work submitted is his/her own and that appropriate credit has been given where reference has been made to the work of others

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Abstract

This thesis presents results of an investigation of the variations in health in the elderly Thai between 2002 and 2007. The analyses are based on the Surveys of Elderly in Thailand in 2002 and 2007. Health at old age is one of the key concerns about population ageing in Thailand because older people are more frails. The differences in health status at old age between areas of residence, individual characteristics and time periods were investigated in this study. The variations of health in old age between areas of residence were measured using multilevel models and the results showed that the differences of health in old age between areas of residences are lower than the differences from individual characteristics.

The rise of expected life years lead to the concern about whether these extra years will be spent in healthy or unhealthy life. To investigate trends of health in old age Thai, this study adopted healthy life expectancy calculated by Sullivan's method as the health measure. Because health has many dimensions, this study calculated healthy life expectancy based on self-rated health, self-care disability and mobility disability to represent different aspects of general health and disability in later life. The results showed that trends in healthy life expectancy varied by age, gender and the health indicators applied.

A population projection for Thailand for 2000-2050 was calculated using the cohort components method. The results showed that based on the assumptions that fertility and mortality continue to decline as recently observed, the number and proportion of old people aged 60 and over will increase rapidly particularly the older old people aged 80 and over and old age women. The disability projection for Thailand in 2000-2050 also showed a large increase in the absolute number and percentage of disabled old age people.

The trends in numbers of old age people and their health in the future result in rises of health expenditure in old age and in the demands for health care services, especially for long-term care and social security. The results from this study then inform policy making and plans for care of the elderly in Thailand in the future.

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Abbreviations

ADL	Activities in Daily Living
ASFR	Age Specific Fertility Rate
CI	Confidence Interval
DFLE	Disability Free Life Expectancy
GDP	Gross Domestic Product
IADL	Instrumental Activities in Daily Living
LE	Life Expectancy
MDFLE	Mobility Disability Free Life Expectancy
MDLE	Mobility Disability Life Expectancy
NESDB	National Economic and Social Development Board
NSO	National Statistical Office
OECD	Organisation for Economic Co-operation and Development
PSU	Primary Sampling Unit
SCDFLE	Self-care Disability Free Life Expectancy
SCDLE	Self- care Disability Life Expectancy
SECAPT	The Socio-Economic Consequences of the Ageing of the Population Survey in Thailand
SRHLE	Self-rated Healthy Life Expectancy
SRUHLE	Self-rated Unhealthy Life Expectancy
SWEOLD	Swedish Panel Study of the Living Conditions of the Oldest Old
SWET	The Survey of the Welfare of Elderly in Thailand
TFR	Total Fertility Rate

CHAPTER 1
INTRODUCTION

1.1 Background

Populations throughout the world are growing older and the number of people aged 60 years and over is expected to increase from 603 million in 2000 to 2 billion by 2050 (United Nations 2009a, United Nations 2009b). In 2009, more than half of the old age population lived in developing countries and this population will grow rapidly to mid-century. Population ageing is the result of the decline of mortality and fertility rates. This implies that the number of old people tends to increase while the number of children is reduced. However, not only are more people surviving to reach old age, but those who attain old age are living longer than ever before. The older population is itself ageing. The fastest growing age group in the world is those aged 80 years or older whom are known as the oldest old (UNFPA 2006a, Kalache and Lunenfeld 2006). One fifth of older persons is projected to be 80 years or older by 2050 (United Nations 2009b).

Thailand is also no exception and the number of population aged 60 and over has increased and is projected to increase further. In 2000, the estimated number of people in Thailand aged 60 and over was 6 million and is projected to reach 19 million in 2050 (United Nations 2009b). The decline in fertility and the improvements in mortality are the demographic forces driving population ageing in Thailand and also in most of Asia (Knodel and Chayovan 2008). Moreover, the pace of population ageing is much faster in developing countries than in developed countries (Knodel et al. 1999) because both mortality and fertility rates have fallen faster in developing countries in recent decades than they did in developed countries in earlier decades. Developing countries are now benefitting from technologies (e.g. immunisations, the contraceptive pills) invented in developed countries. Developing countries are likely to have less time to adjust to the consequences of population ageing. Moreover, population ageing in the developing countries is taking place in the context of much lower levels of socio-economic development than was the case in the developed countries but this is being compensated by much faster rates of economic growth in the emerging economies, of which Thailand is a member, than in developed countries.

The rising number of old people leads to more concern about consequences for their health status and the health system. Health declines with age, particularly beyond age 60. An increase in the older population will mean an increase in ill-health. Old age leads to frailty in the population. Population ageing is therefore likely to lead to more health problems, more health care needs and an increase in health expenditure (Parker and Thorslund 2007). A variety of hypotheses have been proposed to explain how health status changes in the extra years gained from improving life expectancy (Michel and Robine 2004). The first hypothesis is known as the expansion of morbidity. This hypothesis proposes that additions to life expectancy will be spent in worse health. The second hypothesis, the compression of morbidity, argues that the increase in surviving years will be accompanied by improving health status. This means morbidity in old age is compressed. The third hypothesis proposes that the improvement in life expectancy will lead to expansion of poor health but the severity of these health problems will be low. Health status in old age and its trend are important, particularly for health care planning.

Studies of health status and the variations in health of old age have increased at the same time as the population has aged. A variety of health indicators are employed to measure health in old age. For example, self-rated health is used to measure physical health whereas disability in the activities in daily living (ADL), disability in the instrumental activities in daily living (IADL), and disability in mobility are employed to measure dependence in old age. In Thailand there are some studies that investigate the health status of older population. The health indicators used in the studies are long-term disability and self-care disability (Jitapunkul et al. 1999, Jitapunkul et al. 2003). However, the studies in Thailand are based on cross-sectional surveys which contained different health questions. The results then are reported only at one point in time. It is difficult to compare the results or investigate the variations in health over time.

Life expectancy tends to increase, particularly in old age. Some of these extra years will be spent in a healthy state and some unhealthy state. Healthy life expectancy then is introduced to explore the expected health within the total life expectancy gain. While life expectancy quantifies average length of life, *healthy life expectancy* represents the average lifetime in different health states and offers the possibility to evaluate quality of life with respect to health (Rogers et al. 1990). Therefore, longer life in old age may involve more healthy years as well as more unhealthy years. This measurement takes into account both mortality and morbidity concepts. The calculation method for healthy life expectancy is based on the combination of life table measures and health prevalence by age and sex. However, trends of healthy life expectancy are different depending on the health indicators applied (Lafortune et al. 2007, Saito et al. 2003). It is important to harmonise the health indicators used for calculating healthy life expectancy and for making comparison of trends in health in old age.

The health projections are implemented to provide the projected number of old people with different health statuses in the future. Health projections are developed based on calculating conventional population projections with information on health trends (Rogers et al. 1990, Manton and Suzman 1993). The projected number of old people with different health statuses will affect health expenditure in old age, the demands on the health care system and the resource transfers needed to ensure the welfare of the elderly. This knowledge is essential to assist policy makers define, formulate and evaluate policy goals and programmes, and to raise public awareness and support for needed policy changes.

Although there are some studies of health status and healthy life expectancy in old age Thai, none of them have investigated the variations in health over time and in different geographical areas. This study will explore the change in life expectancy and health trends in old age Thai in different ways and also provide the population and health projections to forecast the number of elderly with different health statuses for Thailand. The implications for policy then will be developed by estimating the health spends associated with the health status projections under various assumptions.

1.2 Aims and Objectives of the Research

The principal aim of this research is to ***investigate the variations in health status of the elderly in Thailand and health trends in the future***. In order to achieve the aim, the following research objectives were formulated.

1. To review the health theories, health measurement, health indicators and factors affecting health in old age.

2. To review population ageing in Thailand and the health status of old age Thai.

3. To review and investigate the available data and methods for measuring variations in health of elderly in Thailand.

4. To explore the relationship between demographic characteristics, socioeconomic characteristics, living arrangement and health status.

5. To apply multilevel modelling in determining the geographical variations in health status of elderly Thai.

6. To explore the life expectancy, health status and its variations by calculating Thailand life tables and healthy life expectancy.

7. To project the numbers of elderly in Thailand and their health trends.

8. To investigate consequences of ageing and variations in health in old age on health expenditure, health system and health policy.

9. To evaluate the key findings and limitations of this research and provide the recommendations for future work.

1.3 Thesis Structure

In order to achieve the research aim and objectives as set out in Section 1.2, the thesis is divided into nine chapters. The list of chapters and their objectives is presented in Table 1.1.

Table1.1: List of thesis chapters and their objectives

Chapter	**Objectives**
Chapter 1 Introduction	-
Chapter 2 Population Ageing and Health: Review of Global Context	1
Chapter 3 Population Ageing and Health in Thai Society	2
Chapter 4 Research Resources and Methodologies	3
Chapter 5 Health Status and Geographical Variations	4,5
Chapter 6 Healthy Life Expectancy	6
Chapter 7 Projections of the Population of Thailand and Its Health Status	7
Chapter 8 The Consequences of Variations in Elderly Health and Policy for Thailand	8
Chapter 9 Conclusions	9

Chapter 2: This chapter reviews the definitions of old age based on different perspectives. Then it follows an account of the demographic dynamics of ageing which shows how the demographic transition has led to population ageing in the past which will continue in the future. The relationship between age and health is explored via a discussion of the health transition, theories of health in old age and health measurements. Finally, the health indicators and determinants of health in old age are reviewed.

Chapter 3: This chapter focuses on population ageing and the health situation in Thailand. It starts with a review of population change in Thailand and its impacts on population ageing. The health status of old age Thai is discussed, presenting the past and current situation and challenges for the future.

Chapter 4: This chapter provides details of The Surveys of Elderly in Thailand in 2002 and 2007 including the sampling methods, the sample numbers, the scope of questions and the questions on health. The concepts and equations of multilevel models are explained to aid understanding of how the variations in health of old age by geographical areas will be modelled. The healthy life expectancy calculation methods are reviewed to present the advantages and disadvantages of each method, particularly in terms of data needed.

Chapter 5: The demographic characteristics, socioeconomic characteristics and living conditions of elderly Thai are explored based on The Surveys of Elderly in Thailand in 2002 and 2007. The health status of the Thai population is described using indicators of self-rated health, self-care disability and mobility disability. The variations in health status of old age by demographic characteristics, socio-economic characteristics, living conditions and geographical areas are presented based on the results from multilevel modelling.

Chapter 6: This chapter aims to calculate the life tables and obtain the healthy life expectancies for elderly population in Thailand in 2002 and 2007. The Thailand life tables produced are based on vital registration data. The health prevalence rates of different health indicators from The Surveys of Elderly in Thailand in 2002 and 2007 are applied. Three healthy life expectancies for Thailand are computed: the good health life expectancy based on self-reported health status, self-care disability free life expectancy and mobility disability free life expectancy. The proportion of the expected years in good health to total life expectancy is also investigated to describe the health trends for elderly Thai.

Chapter 7: This chapter describes the population projections for Thailand and then joins the projected number of old age with the assumptions on trends in health status to project the numbers of old people in different health statuses. This chapter also presents the fertility, mortality and migration assumptions input to the population projections.

Chapter 8: The consequences of the increase of the number of the elderly and the changes in their health are explored. The health expenditure for Thailand is estimated and projected to explore the impacts of population ageing and changes in health at old age. This chapter also reviews the current situation of health system and health policy in Thailand. Based on the results from Chapter 5, 6 and 7, guidelines for policy on the health system, social welfare and pension schemes are developed.

Chapter 9: The key findings of this study are summarised to provide the conclusions of the study, referring to how the aim and objectives were fulfilled. The limitations of the study and the possibilities for future work are also described.

CHAPTER 2
POPULATION AGEING AND HEALTH: REVIEW OF THE GLOBAL CONTEXT

2.1 Introduction

It is important to consider the role and contribution of the elderly in society as well as their problems and needs. This section attempts to present some of the evidence about older people in international society which faces a growing population of older persons. It is intended to give the facts and summarise both research findings and the views of others, particularly on the impact of population ageing on health and health system. This chapter will start by clarifying the definition of old age in Section 2.2. There then follows a discussion of the demographics of ageing which aims to identify the trends and determinants of population ageing globally (Section 2.3). Section 2.4 focuses on health status in old age. The review starts from the health transition and follows with the theories of health in old age. Then health measurements and health indicators are explored. The relationships between health, social networks and living arrangements are explored in Section 2.5. The chapter ends with a short discussion and conclusions in Section 2.6.

2.2 Defining Old Age

In many parts of the world, people are considered old because of certain changes in their activities or social roles. Categorical definitions such as the old, elderly, aged and ageing are neither straightforward nor universally applicable. A chronological definition of elderly or aged is commonly used. For example, most developed countries have accepted the chronological age of 65 years as a definition of elderly or older person (Moody 1998). In developing countries, the definition of old age has typically followed that used in ‘developed’ countries. Currently there is no United Nations standard criterion, but the United Nations uses age 60 and over in its statistical analyses of ageing to refer to the older population (United Nations 2001).

The World Health Organization uses categories starting at the age of 65 and over (sometimes 60 and over) for elderly (i.e. older persons) and 80 and over for the 'oldest-old' (Kalache and Lunenfeld 2006). These definitions of old age vary greatly. It is misleading to impose a single chronological definition, whether the cut-off point be 55, 60 or 65 years, to take the threshold ages most commonly used in international statistical comparisons (Wilson 2000). Three main schemes (World Health Organization 2007a), either singly or in combination, are used in research studies to define "older" people: Chronological ages, Capabilities or Functions, and Social Roles.

Chronological ages are used to describe older people. The rationale for using chronological age is that in an age-graded society, people of similar age are likely to be in similar situations and experiencing similar problems. For example, the retirement age or age of entitlement to pension benefits in OECD countries (Duval 2004) are applied with similar ages as presented in Figure 2.1. People in most OECD countries leave the labour force and first receive old age pension benefits at age 65.

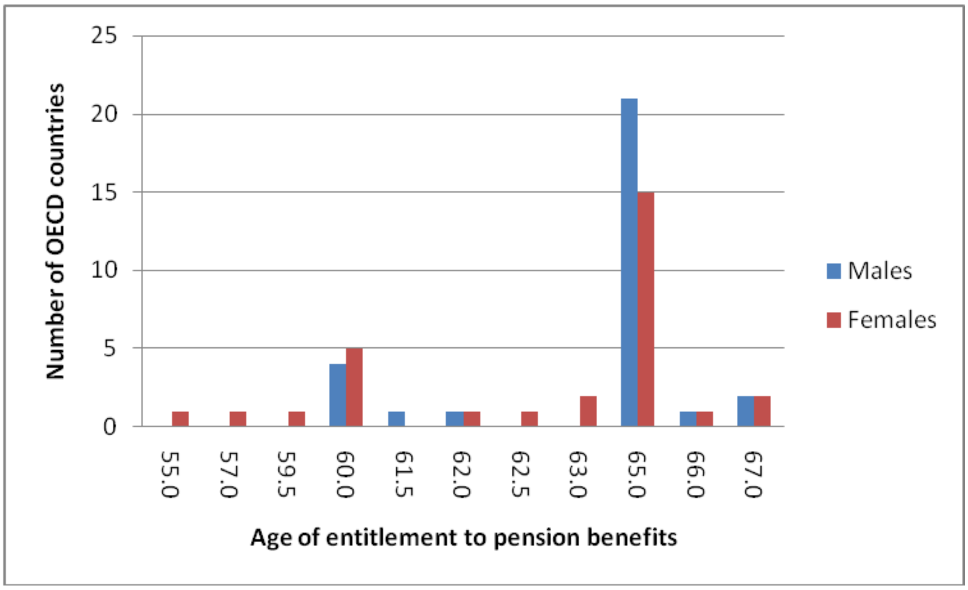


Figure 2.1: Age of entitlement to pension benefits in 2003 in OECD countries
Source: Duval (2004)

However, the range in age for classifying people as aged or in old age varies, resulting in a confusion of definitions that reveal no consensus about when old age begins chronologically. Unfortunately, the age span used is too large, and experiences of older people, even those of the exact same age, are too variable. Generally, the older population ranges in age from 60 or 65 to 105 or more. To deal with this problem, gerontologists have divided the older population into those under 75, those 75 to 84, and those 85 and older. These categories are referred to as the young-old, middle-old, and oldest-old, respectively (Atchley 1994). Nevertheless, the age of 65 remains dominant as the legal definition of when a person becomes older (and entitled to old age benefits) and it also dominates in research.

Functional Schema assigns people to older categories by using observable individual attributes such as physical appearance, mobility, mental capacity and strength (World Health Organization 2007a). However, classifying people into old age categories that rely on functional attributes is mostly an uncertain process and difficult to assess. As a consequence functional scheme is seldom used in research, legislation, or social programmes (Atchley 1994).

Social Role

Classifications into life stage based on social role rely on using a combination of physical and social attributes to categorise people broadly into stages such as adolescence, young adulthood, adulthood, middle age, later maturity and old age. Each life stage reflects an array of physical, psychological, and social attributes or circumstances that are thought to be common to that life stage. The old age life stages based on the social role are characterized by change in family role of population from parent to be grandparent or the changing in working status from working age population to retired population who stopped working completely.

Even though chronological definitions misclassify some people, they are necessary in order to summarize information and make comparisons (e.g. temporal, geographical and cross-national). In this chapter the terms aged, elderly and older people will all be used interchangeably for people aged 60 and over. In doing so the conventional definition used in most studies of ageing in Thailand is adopted and applied throughout this thesis. The threshold age is the age at entry to the state of being old. This old age threshold of 60 is likely to rise in the future as Thai society develops; therefore whenever possible this project will try to use as many age categories above 60 depending on data availability, so that different definitions can be developed and explored.

2.3 The Demographic of Ageing

2.3.1 The Determinants of Population Ageing

Population ageing is the process that results in the proportion of older persons in the total population increasing (United Nations 2001). The increase in the number and the proportion of older persons results from the demographic transition from high to low mortality and fertility and a consequent dramatic increase in the proportion of older persons. Between 1950 and 2000, the total fertility rate (TFR) decreased globally by almost half, from 5.0 to 2.7 children per woman. It is expected to drop to the replacement level of 2.1 children per woman[1] by 2050 (United Nations 2001). The number of children (aged 0-14) tends to decrease as the result of this demographic transition. There are differences between the decrease of fertility in more developed countries and less developed countries. During 2000-2050, TFR in less developed countries is expected to decline and the pace of ageing in these countries is expected to be more rapid than in the more developed countries. Because lower fertility is viewed as providing economic benefits in most developing countries, it was promoted by governments using a variety of measures such as family planning programmes and related family welfare policy (Knodel and Chayovan 2008). This encourages a fast increase in the proportion of the old age population.

[1] Replacement fertility is the fertility level that ensured the replacement of population itself, that is the two children needed to replace father and mother. But this is true only the sex ratio at birth is 1 and female child survives until female grandchild was born. The replacement fertility varies depend on mortality and sex ratio at birth. (Smallwood and Chamberlain 2005).

Nevertheless, as the transition has gone on to later stages, mortality decline, particularly at the older ages, has increasingly become the more important factor in shaping the relative size of the oldest age groups globally. Over the period 1950-2000, life expectancy at birth increased globally by almost 20 years, from 46.5 years in 1950-1955 to 66 years in 2000-2005 (United Nations 2006a). The improvement in life expectancy increases the number of people who reach old age. The impacts of the demographic transition on population ageing in less developed countries are higher than more developed countries due to the old age population in less developed countries having lower levels of socio-economic development (UNFPA 2006b).

2.3.2 Trends in Population Ageing

The United Nations report *Population Ageing 2006* suggests that by the year 2050 the number of persons aged 60 years or over is projected to grow to almost 2 billion from 688 million in 2006 (Table 2.1). In 1950 at the global level, 1 in every 12 individuals was aged 60 and over and 1 in every 20 individuals was 65 and over. This proportion of older persons will increase by 2050 when more than 1 in every 5 persons will be aged 60 and over and nearly 1 in every 6 persons is projected to be aged 65 and over (United Nations 2001). The percentage of older persons is currently much higher in more developed regions than in the less developed regions, but the rate of ageing in developing countries is more rapid (United Nations 2006a). As a result, the proportion of the world population aged 60 and over living in less developed countries increased from 54% in 1950 to 62% in 2000 and it is expected to reach 80% by 2050.

However, not only are more people surviving to reach old age, but those who attain old age are also living longer than ever before. Currently, United Nations (2006a) statistics suggest that the oldest old (aged 80 years or over) make up 13 percent of the population aged 60 or over and this share will reach 20 percent by 2050. In addition, the number of centenarians (aged 100 years or over) is projected to increase from approximately 0.3 million in 2006 to 3.7 million by 2050. The shifting in age structure has a profound impact on a broad range of economic, political and social conditions as populations become older.

Table 2.1: The number and life expectancy of people aged 60 or over for selected regions and countries

Country/Area	**Number (thousands)**		**Percentage of increase 2050/2006 (%)**	**Percentage of Total Population**		**Life expectancy at age 60 Men/Women**
	2006	**2050**		**2006**	**2050**	
World	687 923	1 968 153	286	11	22	17/21
Europe	151 841	225 373	148	21	34	18/22
Northern Europe	20 517	31 916	156	21	30	19/23
United Kingdom	12 837	19 741	154	21	29	20/23
Asia	374 802	1 231 237	329	9	24	17/20
Eastern Asia	374 802	506 956	135	13	32	17/21
China	147 799	431 532	292	11	31	17/20
Japan	34 751	46 748	135	27	42	22/27
South-Eastern Asia	45 117	174 959	388	8	23	17/19
Thailand	**6 945**	**20 702**	**298**	**11**	**28**	**17/20**
Singapore	561	1 983	353	13	38	20/23
Malaysia	1 847	8 405	455	7	22	17/19
Viet Nam	6 358	29 768	468	7	26	18/20

Source: United Nations (2006a)
Note: The life expectancies are period expectancies, i.e. dependent on the profile of age- specific mortality rates. Alternative life expectancies are based on cohort age-specific mortality rates which used projected and therefore depend on the projection model and the assumption used.

The trend of population ageing by gender also shows that older women will be the majority of the older population because their life expectancies are greater than men (United Nations 2001). This means that men are more likely to have a spouse available to provide care in old age than are women.

2.4 Health Status of the Elderly

Health is one of most pressing concerns to the elderly population and is closely linked to other aspects of wellbeing of the elderly. Health is a matter of prime importance for older people because it is staying well that helps them to remain independent. Healthy elderly make fewer demands on social and familial supports compared to elderly with poor health (Chayovan and Knodel 1997). However, increasing longevity can also result in rising medical costs and increasing demands for health services, since older people are typically more vulnerable to chronic diseases. Many developed countries are now having problems coping with the high costs of health care and social welfare of their growing elderly population (Tinker 1997). Thus health status and related conditions of the elderly are of interest to study.

Ageing is an integral, natural part of life. Ageing is a slow but dynamic process which involves many internal and external influences, including genetic factors and physical and social environment (Victor 1994, Streib and Binstock 1990, Victor 1991). The ways in which people grow old and experience this process, through changes in levels of health and functional ability, depends not only on genetic makeup, but also on what people have done during their lives, what life-events and experiences have been encountered, as well as how and where lives have been lived. With the process of ageing, most organs undergo a decline in functional capacity. With the rapid and continuing growth of elderly populations in many countries, it has become an important and urgent matter to look for ways to maintain and improve the functional abilities of ageing people, to help them cope independently in the community. In particular there is a need to provide support so that they can participate in community events, visit other people, make use of public services and facilities, and generally enrich their own lives and those of the people closest to them. The lowered level of physical activity and the growing number of chronic illnesses that are often experienced with increasing age frequently create a vicious circle of illnesses and related disabilities (Victor 1994).

Older people differ in three ways from the young in term of their morbidity patterns: the type and number of diseases and accident experiences, the reactions and experiences to disease experienced and the context in which they experience disease and illness. The elderly often have a multiplicity of diseases and illnesses partly accounted for by the accumulation of chronic non-fatal health conditions. Also, they are more likely to experience falls than any other age groups except the under-fives.

In addition, there is a greater incidence of both acute and chronic sickness among older people than in other age groups (Tinker 1997).

2.4.1 Health Transition

Epidemiological change is a crucial feature which often accompanies population ageing. The concept and stages of epidemiological transition are outlined by Omran (1971). In general terms epidemiological transition theory proposes that the major sources of death will no longer come from infectious diseases but from chronic and degenerative conditions. It has long been recognized that higher rates of chronic and degenerative diseases (heart diseases, cancers, and strokes) are most associated with ageing populations (World Health Organization 1989). However, in developed countries, there is some discussion on a fourth stage of the epidemiological transition which involves "longer life but worsening health". Older populations may live longer and suffer less from serious degenerative diseases but they may suffer from more chronic and partially disabling conditions. The disability in old age results in dependency of the elderly people on others to maintain their life. Although many older people are fit and healthy, on average, ageing populations require more health and support services because of the nature of health conditions involved.

Most developed countries are now well established in a new phase of the demographic transition which is characterized by major declines in adult mortality and fertility. Recent mortality trends have certainly been positive for the elderly and their expected survival. Future mortality declines, particularly among the elderly, are feared because of the increase in elderly proportion that will result and the responsibility they expect from society to resolve the problems arising from longer survival. These problems are not just a question of guaranteeing longer life expectancy but also of ensuring an acceptable health status. Indeed, the increased life expectancy of the elderly is always accompanied by debate about the quality of survival and whether the year gained or to be gained will be spent in good or in poor health. There is some evidence to show that the increase in the number of years spent at older ages could imply an overall decline in the mean health level of the population (Spiers et al. 1996, Parker et al. 2005, Crimmins and Saito 2000). Other researchers maintain that these gains in survival may not only postpone the age of death, but also mean that older people enjoy better health than prior generations. However, the concept of health has changed over time and this has affected health assessments. Some progress has been made in providing an objective measurement of health status based on the absence of impediments or functional limits to daily life though there is far from universal agreement about the battery of indicators that should be used in health surveys.

2.4.2 Hypotheses of Health Transition

The different hypotheses that have been proposed to explain changes in health status can be classified into three general groups, namely morbidity expansion, morbidity compression or dynamic equilibrium.

Pandemic of disability or expansion of morbidity (pessimistic view)

This hypothesis predicts that the proportion of life lived with disability will increase as mortality declines. According to Gruenberg (1977), the decline in mortality rates is the result of a decline in fatality rate of chronic diseases rather than a decline in the incidence of these diseases or a slowing in their rate of progression. The postponement of death will result in a worsening of the severity of chronic diseases.

Compression of morbidity (optimistic view)

The hypothesis of the compression of morbidity was first proposed by Fries (1980). Fries argues that, with improvements in survival, the prevalence of disability will decrease and, therefore, the proportion of life lived with disability will also decrease (Fries 1980 and 1990). This theory postulates that if the morbidity period is defined from the onset of chronic infirmity until death, and if the time occurrence of such morbid events can be postponed, and if adult life expectancy is relatively constant, then morbidity will be compressed into a shorter period of time.

Dynamic equilibrium

Manton (1982) has proposed another view of the health transition, namely "dynamic equilibrium". According to this concept, the increase in life expectancy is in part explained by a slowing down in the rate of progression of chronic diseases by medical intervention. Thus although the decline in mortality leads to an increase in the prevalence of chronic diseases, these diseases will general be milder in character.

The graphs representing these three morbidity-mortality hypotheses are shown in Figure 2.2. The graphs plot survival probabilities, without illness and with illness, against age between x_1 and x_2 for two time points, t=1 and t=2 respectively.

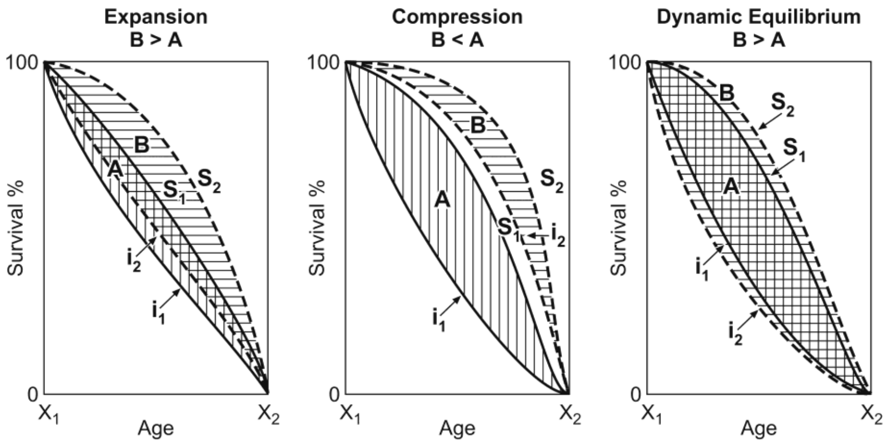


Figure 2.2: The three hypotheses of morbidity and mortality change

The lines on the graph labelled i_1 and i_2 are survival curves for people without illness (in good health, without disability). The lines on the graph labelled s_1 and s_2 are total survival curves for people at two points in time. In the Figure, the leftmost graph shows what happens when a population experiences an expansion of morbidity. Area A (area between s_1 and i_1) on the graph represents people with illness at t=1. Area B (which includes some parts of area A) represents people with illness at t=2. Area B is larger than area A. This is expansion. The middle graph shows what happens when a population experiences compression of morbidity. Area A on the graph represents people with illness at t=1. Area B represents people with illness at t=2. Area B is much smaller than area A. This is compression. The rightmost graph shows what happens when a population experiences equilibrium of morbidity. Area A on the graph represents people with illness at t=1. Area B represents people with illness at t=2. Area B is larger than area A (area A is part of area B). This implies that even the number of people with illness at time 2 is higher than at time 1 but the illness at time 2 is less severe than time 1. This is equilibrium.

2.4.3 Measures of Health Status

Mortality

Mortality is the most widely used index of health status (Victor 1994). It is widely employed as a health indicator because the data are easily and routinely available. Nevertheless, when analysing mortality data for the elderly, we must be aware of the limitations resulting from inaccuracy in the reporting of cause of death among the older age groups (Jitapunkul et al. 1999). Mortality is a useful index for comparing health status between groups or populations living in geographical areas. However, its applicability as a measure of health is obviously limited in that it tells us nothing about the status of those who have not died. The use of mortality as an indicator of health status assumes that it is a measure of reasonable general morbidity and that therefore morbidity and mortality in the older population is the same (Victor 1991). This is an unrealistic and highly questionable assumption for studies of older age groups who experience much morbidity in terms of disabling illnesses but these results in very few deaths. The difference between mortality incidence and morbidity prevalence is roughly an order of magnitude. In a population we might observe a mortality incidence rate of 10 per 1000 population but a morbidity prevalence rate of 100 per 1000 population.

Morbidity

To solve the problems of using mortality statistics as an indicator of health, numerous morbidity measurements have been defined (Robine et al. 2001). The most common approach uses measures that relate to the prevalence of limiting illness among the population. These indicators usually differentiate between acute health problems and chronic health problems. Acute health problems are usually defined as self limiting conditions of short duration, usually three months or less for example, colds, influenza or injuries. Usually acute illnesses are characterised by symptoms or causes for which medical intervention or other interventions are needed. Chronic health problems are long term and not usually characterised by a cure. Examples of such long term health problems are multiple sclerosis and arthritis. They are these types of health problems which are associated by the general public and many professional health workers with old age.

Disability is a commonly used way to look at chronic health problems in the elderly (Iwarsson et al. 2007, Matthews et al. 2006). The focus is on the ability of the elderly to undertake a variety of activities and tasks considered essential to an independent life in the community. The trend in disability is expected to be affected by health problems such as diseases or disability conditions. For example, the decline in strokes should reduce the difficulty of some people to get around the house. Disability is particularly useful because of its close correlation with a need for social services.

Healthy Life Expectancy

Healthy life expectancies are significant indicators representing the health status of elderly people (Robine et al. 2001) because they provide a means of dividing life expectancy into life spent in various states of good and bad health, thus extending the concept of life expectancy to morbidity and disability. Healthy life expectancies (generally disability-free life expectancy) are now increasingly used in developed countries to assess the health status of the population especially, in older people. One measure of health is active life expectancy, sometimes known as disability-free life expectancy (DFLE). This is defined as “the average number of years that a person of a given age may expect to live free of disability” (Tinker 1997:70).

At present, healthy life expectancy has become an important measure of population health at both national and international level (Crimmins et al. 1989, Breakwell and

Bajekal 2006). The interest in healthy life expectancy has grown as the impact of an increase in the proportion of elderly people which will lead to a higher demand for health and social care in the future (Bebbington 1988). There are a number of ageing studies which reported that elderly people have achieved a longer life, but in worse health (Bebbington 1988, Wilkin and Adams 1983, Crimmins et al. 1994, Rogers 2007). As a result, healthy life expectancies were developed as a population health indicator that combined mortality and morbidity. Moreover, healthy life expectancy has two advantages over other measures. First, it is relatively easy to explain the concept to a non-technical audience and second, it is measured in years of life which are meaningful for the general public (Jagger et al. 2007).

To calculate healthy life expectancy at a particular age and time, it is necessary to compute the number of person years lived in the health state from that age and time. Thus, theoretically, estimates of healthy life expectancies at this time depend on the prevalence of the healthy state and are essentially cohort measures (Jagger et al. 2007, Mathers and Robine 1997). Direct calculation of the person years lived in the health state requires longitudinal data (which is not readily available in many contexts including Thailand) to provide the transitional rate between health states (this is the multistate method). The Sullivan method is of particular practical importance as it uses more readily available data: age-specific prevalence of the health state and the total person years lived at a particular age. Obviously some error is associated with this approximation (except if all population characteristics are stable over time) but many researchers have shown that the Sullivan method can be recommended for its simplicity, relative accuracy and ease of interpretation (Mathers and Robine 1997, Bebbington 1988, Jagger et al. 2007). The Sullivan method is considered in Chapter 4 and 6 and is followed by consideration of the multistate method.

2.4.4 Health Indicators

Disease

Disease is one of the common morbidity indicators which reflect a need for medical care. However, it may describe little about the need for health care service if there is no clinical information about the severity of that disease (Parker et al. 2005). The level of disease reported or recognised depends on the knowledge of diseases, diagnostic ability and the use of health care. For example, improvement of screening methods and use of medical care for older people in the United States led to dramatic increases in self-reported hypertension (Waidmann et al. 1995).

Self-rated Health

Self-rated health is a health indicator which asks respondents to rate their own general health on three or five point scales. Self-rated health presents the overall personal assessment based on facets of health such as diseases, conditions, impairments, functional losses and disabilities. It reflects the total picture of health as perceived by the individual (Idler et al. 1999). Many studies of self-rated health in the elderly show a high correlation with the diagnoses contained in medical records (Simpson et al. 2004). Self-rated health has become a widely used health indicator due to its ease of administration and reliability (Idler et al. 1999). However, many surveys include items that ask about specific health problems, either diseases or symptoms. Questions about symptoms require only that the respondent remember and report the symptom. Health status in old age measured through self-rated health appeared to improve in Australia and the United States.

- A study of the health of the Australian population aged 60 to 84 between 1978 and 1998 showed improvement in self-rated health (Doblhammer and Kytir 2001).
- A study in the United States found improvement in the self-rated health of population aged 65 and over between 1993 and 2001 (Zack et al. 2004).

However, studies in United Kingdom, Sweden and Netherlands found that self-rated health had become worse.

- The self-rated health became worse in UK during the 1980s (Spiers et al. 1996).
- The result from the Swedish Panel Study of the Living Conditions of the Oldest old (SWEOLD) showed the worsening of self-rated health between 1992 and 2002 (Parker et al. 2005).

Activities in Daily Living (ADL) and Instrumental Activities in Daily Living (IADL)

ADL and IADL are the most commonly used health indicators for old age as in particular they can measure the ability of a person to provide for their personal care and so to continue living independently. Disability in old age is closely correlated with need for care and social services. Most researchers measure the degree of disability using some form of an activities in daily living (ADL) which generally includes bathing, toileting, dressing, transferring, feeding and grooming (Katz 1983), while the instrumental activities in daily living (IADL) include ability to clean the house, prepare food and shop for groceries. The inability to perform ADL normally represents severe disability whereas the inability to perform IADL refers to moderate disability (Michel and Robine 2004). However, researchers now widely use ADL to measure health in both clinical studies as well as community-based surveys of elderly people (Freedman et al. 2002, Heikkinen 1996). A study in United States showed increasing ADL limitation (Crimmins and Saito 2000) while a study of IADL found a decrease in IADL limitations (Schoeni et al. 2001). A study in Sweden using ADL and IADL limitations stagnated between 1992 and 2002 (Parker et al. 2005).

2.5 Health Determinants in Old Age

We now consider the factors that may determine a person’s health status in old age.

2.5.1 Social Networks and Health in Old Age

With regard to social contact, there is considerable evidence that restricted social networks and support significantly predict increased morbidity and mortality in older people. Peat et al. (2004) reported that the number and frequency of contacts for most social ties (children, close relatives and close friends) decline with age. He also found that being widowed, the absence of close friends, and the absence of close relatives for women were positively associated with increased likelihood of interference with daily activities (Peat et al. 2004). Support received from social networks can buffer stress and improve coping at all stages of life. There is a close relationship between the personal network characteristics and the mental and physical health of elderly people (Wenger 2002).

There is considerable evidence that social support is related to health status at various points in the life cycle and particularly in later life. The literature suggests that the construct of support network type may have a potentially meaningful association with health status in old age and socio-demographic background (Tomas et al. 1985). Litwin (1998) studied the relationship between type of social network and health status in old age. Litwin (1998) found that people with resourceful and diversified networks of friends and neighbours had better scores on measures of basic activities of daily living and self-rated health, even when controlling for respondents' age, sex, and education. The narrow family focused network had average health ratings with low and moderate support capability.

2.5.2 Housing and Health in Old Age

Ageing at home is a goal that many older people living in the community aspire to. It has been estimated that older people spend most of their time in their home (Windle et al. 2006). Therefore, an 'appropriate' living environment is crucial to maintaining independent living. However, the role of the physical home environment in promoting or restricting performance of everyday tasks in older people is poorly understood (Gitlin 2003). Retaining independence and autonomy is recognized as being important to maintaining quality of life. For older people, stable or deteriorating health is widely acknowledged as one of the key elements of the ageing process. Yet health and mobility difficulties can be exacerbated by an inappropriate home environment, affecting the ability to manage at home, which can impact on independent living.

Many old people live in less than desirable housing and some groups have particular problems. There is evidence that some people remain in residential care only because alternative accommodation is lacking. The elderly usually live in accommodation without amenities and also find themselves in older housing (Wheeler 1986). A likely reason is that their income and wealth is generally lower than people in full-time employment.

Some researchers show that environmental hazards are common in the homes of the elderly with and without physical disabilities (Gitlin 2003). Common hazards found in all rooms include the lack of grab bars, loose throw rugs and obstructed pathways, whilst bathrooms have been observed as the most hazardous room (Northridge et al. 1995). Accidents and falls, in particular, are among the commonest causes of death and disability in old people (Northridge et al. 1995). Poor housing conditions can increase the risk of accidents and the rate of accidents requiring medical attention increases dramatically with age (Fisk 1986). However, the majority of the elderly, despite their experience of accidents, generally regarded their home as a safe place to live and did not seek to rectify the hazards that may have been the cause of ill health and death.

However, difficulties experienced at home by some older people are related to their functional status and are not necessarily a reflection of the condition of the property. On the other hand, if functional limitations are exacerbated by inappropriate housing conditions, then some occupants could face an increased risk of a poor health outcome. It is not being suggested that health outcomes are a consequence of poor housing but there are a number of factors related to housing that are indicative of potential health risks (Fisk 1986, Evans et al. 2002, Iwarsson et al. 2007).

2.6 Discussion and Conclusions

This chapter has reviewed trends in population ageing and the consequences on health status in a global context. The definition of old age is varied, depending on countries or organisations. However, generally it is defined based on chronological age of 60 or 65. Although the old age definition is varied, the old age population was found to increase both in absolute numbers and relative numbers worldwide. The key determinants of population ageing are the decline in mortality and decrease in fertility rates. More population was expected to reach old age than in the past particularly in developing countries, in which population ageing was found to be increasing faster than in developed countries. Population ageing is the result of the improvement in survival of the population but the extra years gained lead to concern about their health status in later life because the major cause of death has moved from infectious diseases to chronic and degenerative diseases as explained by the epidemiological transition. There are three hypotheses about trends in health in old age – morbidity expansion, morbidity compression and dynamic equilibrium. The proportion of life lived with morbidity is expected to increase as same as life expectancy increase is morbidity expansion occurs. If morbidity compression occurs then increasing life expectancy will be accompanied by a decrease of life with morbidity. The dynamic equilibrium hypothesis expects the proportion of life with morbidity to increase but the level of this morbidity to be milder. To measure whether health in old age improves or not, various health measurements and health indicators have been developed. Healthy life expectancy is the key summary indicator that measures health in old age by dividing life expectancy into various health states. However, healthy life expectancy varies depending on the health indicator used. Disease, self-rated health and disability in ADL and IADL are employed in most recent studies of health in old age because they represent the key health problems in later life. Based on healthy life expectancy concepts, the hypotheses about health in old age can be tested. However, the difference in health in old age can be found as a result of different in demographic, socioeconomic and living arrangements. Population ageing in Thailand will be reviewed in the next chapter along with evidence about the health status of older Thai people.

CHAPTER 3
THE ELDERLY IN THAI SOCIETY

3.1 Introduction

Thailand is one of the South East Asian countries which now faces an increase in the number of old people (UNFPA 2006a). The continuing increase in both the number and proportion of the population aged 60 years and over leads to the concern about the consequences on the demand for health care, economic security for older people and their living arrangements. Moreover, the old in Thailand tend to live longer than in the past, particularly old women. The increase of the oldest old or population aged 80 years and over is faster than for the younger old ages. This implies that the proportion of the old who are frail will increase, because frailty increases with increasing age. The high proportion of old age women also leads to health concerns, especially about disability in old age, because many studies have found that elderly women tend to live longer than elderly men but with more disabilities. Maintaining good health status in old age then is considered as the key factor for reducing the consequences of population ageing. This chapter aims to review population change, the population ageing situation and trends in Thailand in Section 3.2. Then follow a description of the demographic characteristics of old people in Section 3.3. A review of the health situation for older Thai is presented in Section 3.4. The health system and social security in Thailand, particularly the health system for old age, are reviewed in Section 3.5. The chapter concludes with a summary of key points in Section 3.6.

3.2 Population Change and Ageing in Thailand

During the past several decades, Thailand has experienced significant fertility decline within a short period of time. The total fertility rate has declined from over 6 births per woman in the mid-1950s to lower than 2 in the mid-2000s (Table 3.1). During the same period, life expectancy at birth increased from 49.2 years to 63.7

years for men and 52.6 years to 74.0 years for women (United Nations 2006a). In the coming decades, besides the lowering of the growth rate, a major demographic consequence of this rapid fertility reduction will be an inevitable ageing of the population. Even more dramatic will be the rapid increase in the size of the older population (age 60 and over), a result of past high fertility levels and substantial declines of mortality.

Table 3.1: Life expectancy at birth and total fertility rate in Thailand, 1950-2050

Year	e_0 Male	e_0 Female	TFR
Estimates			
1950-55	49.2	52.6	6.40
1960-65	54.4	58.0	6.39
1970-75	58.0	63.1	4.96
1980-85	61.7	68.0	2.85
1990-95	64.0	71.2	2.00
2000-05	63.7	74.0	1.83
Projections			
2010-15	67.8	75.7	1.85
2020-25	70.3	77.4	1.85
2030-35	72.3	79.0	1.85
2040-45	74.0	80.4	1.85
2045-50	74.9	81.8	1.85

Source: United Nations (2006a)
Notes: e_0 = life expectancy at birth, TFR = Total Fertility Rate (children per woman)

The proportion of the population aged 60+ is anticipated to increase from 10.1 percent in 2000 to 18.5 percent in the year 2020, 24.0 percent in the year 2030, and 30 percent in the year 2050. The population projection in Table 3.2 suggests that the number of older persons aged 60 and over will continue to rise, from approximately 6.1 million in 2000 to 8.5 million in 2010 and will reach 20.0 million by 2050. Based on the 2006 projections from the United Nations, the growth rate of the Thai older population is 2.2 percent per year. With this growth rate, the size of the older population will have doubling times of about 32 years.

Table 3.2: Projected trends of the older population in Thailand 1950-2050 (thousands)

Year	Total	Age 60+		Age 65+		Age 80+	
		Number	**%**	**Number**	**%**	**Number**	**%**
Estimates							
1950	20,607	1,041	5.0	669	3.2	85	0.4
1960	27,652	1,411	5.1	867	3.1	95	0.3
1970	37,247	2,002	5.4	1,268	3.4	138	0.4
1980	46,809	2,697	5.8	1,778	3.8	215	0.5
1990	54,291	4,225	7.8	2,652	4.9	343	0.6
2000	60,666	6,130	10.1	4,063	6.7	602	1.0
Projections							
2010	65,125	8,463	13.0	5,675	8.7	1,073	1.6
2020	67,990	12,611	18.5	8,413	12.4	1,603	2.4
2030	69,218	16,596	24.0	12,069	17.4	2,259	3.3
2040	68,940	19,059	27.6	14,600	21.2	3,669	5.3
2050	67,376	20,071	29.8	15,683	23.3	4,732	7.0

Source: United Nations (2006a)
Notes: % = 100 x (population in age group/population of all ages)

Among the old (aged 60 and over), women constitute a majority of Thailand's older population. At birth there is an approximate balance in the sex ratio with 103 males to 100 females. The United Nations estimated that the life expectancy at birth of females was higher than males during the period 1950-2005 for Thailand (Table 3.3). This difference in life expectancy at birth between males and females is projected to continue in the next 40 years based on the United Nations population projection (United Nations 2007c). Moreover, the projected life expectancy at age 65 and 80 indicate that elderly women tend to live longer than men. In 2005-2010, the life expectancy of males and females at age 65 were 13.9 and 16.4 years, respectively; and at the age 80 were 5.9 years for males and 7.0 years for females (Table 3.3). Due to higher female life expectancy, women outnumber men in older age groups and the ratio of males to females declines with age. In 2005, women constituted 50.6 percent of the Thai older population and 66.9 percent of the oldest old population. Projections show that women will continue to be more than 60 percent of the oldest old population in 2025 (UNFPA 2006a).

Table 3.3: Life expectancy (e_x) at different ages by sex in Thailand between 1950-1955 and 2045-2050

e_x	**Birth**			**65**			**80**		
	M	**F**	**F-M**	**M**	**F**	**F-M**	**M**	**F**	**F-M**
1950-55	48.9	53.3	*4.5*	-	-	-	-	-	-
1975-80	60.6	65.7	*5.1*	-	-	-	-	-	-
2005-10	68.5	75.0	*6.5*	13.9	16.4	*2.5*	5.9	7.0	*1.1*
2025-30	73.6	79.1	*5.5*	14.9	18.7	*3.8*	6.2	8.5	*2.3*
2045-50	76.5	81.5	*5.0*	16.3	20.0	*3.7*	7.1	9.4	*2.3*

Source: United Nations (2007c)

The life expectancies in Table 3.3 indicate that an increase in life expectancy was found in both males and females and at all age groups. But the rise in life expectancy for females was greater than for males, particularly in life expectancy at old age. The gender gap in life expectancy at birth between males and females in 1950-1955 was 4.5 years and then increased to 5.1 and 6.5 years in 1975-1980 and 2005-2010 respectively.

This expansion of gender gap in life expectancy at birth in Thailand might be the result of the difference in benefits from gender equality and level of development between males and females. In less developed countries (LDCs), the higher the level of gender equality and of development (in the economic, political and educational domains), the greater the gender gap in life expectancy (Medalia and Chang 2010). The rise in gender equality in LDCs is associated with higher levels of women's employment which increase women's earnings. These transitions associated with the increase in female life expectancy relative to male are also associated with increasing parental preferences for daughters, reduction in female mortality at young ages, reduction in time at risk from indoor pollution, and increasing the use of reproductive health interventions (Medalia and Chang 2010).

Although the gender gap in life expectancy at birth in Thailand expanded during the 1950-2010 period, this gap is projected to decrease in the next 40 years according to the United Nation projection. The difference in life expectancy at birth is projected to reduce from 6.5 years in 2005-2010 to 5.0 years in 2045-2050 (Table 3.3). The narrowing of the gender gap in life expectancy at birth was found in highly developed countries (HDCs) (Medalia and Chang 2010). Associated with the increase in gender equality in HDCs has been a rise in more risky behaviours by women such as smoking and alcohol consumption while these behaviours were reducing in males. Males then tend to derive more benefits from the reduction of smoking and alcohol consumption related mortality than females (Zatonski et al. 2007, Smith 2004). However, the gender gaps in life expectancies at age 65 and 80 in Thailand were projected to expand from 2005 to 2030 and then to remain constant during the 2030 to 2050 interval. The increase of the gender gap in life expectancy at old age in Thailand might due to the improvement of women's health since 1950-1955 being carried forward beyond 2005 as those cohorts become old. So they will continue to gain an advantage over Thai men.

A much higher proportion of older women than older men live without a spouse. The Survey of the Elderly in Thailand 2002 reported that 45 percent of older women, as against 15 percent of older men, did not have a spouse (NSO 2002). Older Thai women face disadvantages relative to men: they have a lower level of literacy; they experience longer periods of widowhood; more of them live alone with a significantly lower household income; they suffer higher levels of morbidity and disability; they have a lower likelihood of receiving formal retirement benefits or social security support. There are more elderly women than men faced with poverty, neglect and abuse (Sobieszczyk et al. 2003, Chayovan and Knodel 1997).

Jitapunkul et al. (1999) reported that women live longer than men and will make up a higher proportion among the oldest old. Many of the very old would be women, often widowed and probably without adequate means of support. They are likely to have poorer health and a worse financial situation compared to older men. Older women are thus considered more vulnerable and deserve special attention and assistance (Jitapunkul et al. 1999).

Another important feature of the population ageing in Thailand is the increasing proportion of the oldest old which means the population aged 80 years or over. Increasing survival rate to age 80 years means that more and more the older persons will live to and beyond 80 years. Currently this is 3.6 percent and will increase to 5.6 percent by 2050 and the population of oldest old, currently estimated at 590 thousand, will increase to 1.3 million in 2025 and exceed 3.5 million by 2050 (UNFPA 2006a). This means an extended duration of social security and welfare payments and an increasing need for care of old age morbidity and disability.

3.3 The Demographic Characteristics and Living Arrangements of Old Age Thai

3.3.1 The Demographic Characteristics

In Table 3.4, the data show that the percentage of old age men is greater than old age women at ages 60-69. Beyond age 70 the percentage of old age women was higher than men. Moreover, we can see that, as of 2002, 12.8 and 20.7 percent for older Thai men and women respectively, have never attended school. 75 percent for men and 71 for women have achieved primary school education (NSO 2002).

Table 3.4: Percentage of Thai elderly by population characteristics, 2002

Population Characteristics	Male	Female
Age group		
60-64	33.3	29.9
65-69	26.1	25.2
70-74	19.0	20.0
75-79	11.7	12.0
80 and over	9.9	12.9
Total	100.0	100.0
Marital status		
Single	1.6	4.6
Married	82.3	45.7
Widowed	14.8	47.6
Divorced/Separated	1.3	2.1
Total	100.0	100.0
Education		
No education	12.8	20.7
Primary School	74.8	71.4
Secondary School	12.4	7.9
Total	100.0	100.0

Source: NSO (2002)

Therefore, older men are more highly educated than older women. Having a partner or not in the later year of life is likely to have important implications for psychological, and perhaps, material well being of older persons. It also affects their living arrangements and support systems. Therefore, information on the marital status composition of older persons is important for assessing the support needs of the elderly. The data from the Survey of Elderly in 2002 (NSO 2002) reported that more than 80 percent of Thai older men were married; this proportion is higher than that of women. Furthermore, widowhood is more prevalent among older Thai women (47.6 percent) than men (14.8 percent). These patterns result from the tendency of Thai men to marry younger women, who tend to out-survive them (Chayovan and Knodel 1997, Knodel et al. 1999).

3.3.2 Household Structure and Living Arrangement in Thailand

For older persons who live in private households, most live with their children or spouse. Only 2.2 percent of older (60 and over) men live alone and 4.8 percent of older (60 and over) women (Table 3.5).

Table 3.5: Living status of elderly by age and sex, Thailand 1996-1997

	Living Arrangement (%)				
	Alone	**With spouse**	**With children**	**With other relatives**	**With non-relatives**
Male					
60-64	2.1	55.4	41.7	0.5	1.0
65-69	2.2	47.8	47.8	0.8	1.8
70-74	2.3	47.7	46.5	0.3	3.2
75+	2.0	36.0	58.4	1.6	2.2
Total	2.2	48.7	47.0	0.7	1.9
Female					
60-64	4.4	41.9	51.7	1.1	1.5
65-69	4.0	41.3	51.9	1.3	1.6
70-74	5.1	34.8	55.2	1.7	3.4
75+	6.5	27.2	57.4	3.3	5.6
Total	4.8	37.6	53.5	1.7	2.7

Source: Jitapunkul et al. (1999)

Most of Thai older persons share the same house with their children (71%). Another 9.4 percent live in accommodations adjacent to their children's homes and 7.4 percent dwell in the same community with their children. Among those who do not co-reside with their children, most of them are regularly visited (at least once a month) by their children (Chayovan and Knodel 1997). Almost 50 percent of older persons in Thailand live in three generation households (Jitapunkul et al. 1999).

Given the rapid fertility decline in the past three decades in Thailand, the elderly will have fewer children. Estimates indicate that the older persons in 1992 have on average 5.1 living children (Table 3.6). Moreover, the percentage with just two children will increase from 8 per cent to 58 percent, while the percentage with five or more living children will decrease from 56 percent to only 4 percent. The proportion of older persons who have no child increased slightly from 3.5 percent in 1986 to 4.4 percent in 1995 and the figure is expected to increase in the future (Chayovan and Knodel 1997). The rapid fertility decline is often cited as a force that will affect the system of family support of older persons. The reduction of family size implies that there will be fewer children available to provide care and support for the future generations of elderly. Ninety-three percent of older persons want their children to be their care givers when they get older and need assistance (NSO 2002).

Table 3.6: Percent of older persons in 1992 according to their actual number of living children

Number of children	**Male**	**Female**	**Total**
0	3.4	3.6	3.5
1	6.0	9.8	8.2
2	8.3	7.7	8.0
3	9.9	12.2	11.2
4	12.7	13.0	12.9
5+	59.8	53.7	56.2
Total	100.0	100.0	100.0
Mean number	5.4	4.8	5.1

Source: Knodel et al. (1999)

The population ageing concerns are growing about the long-term viability of intergenerational social support systems, which are crucial for the well-being of both the old and younger generations (Knodel et al. 1999, Sobieszczyk et al. 2003). However, the provision of care within the family becomes more and more difficult as family size decreases and women, who are traditionally the main caregivers, increasingly engage in employment outside the home. An important consequence of fertility decline is a progressive reduction in the availability of kin to whom future generations of older persons may turn for support. This process may have a significant impact on the well-being of older persons, especially in the less developed regions where social support for the older person is largely provided by the immediate family.

3.4 Health Status of Elderly Thai

3.4.1 Mortality

To establish the health status of elderly Thai, mortality status is used because there is a high correlation between mortality and morbidity as the first precedes the majority of death. Mortality data also are more widely available in standard form than morbidity data. The age specific mortality rate for Thailand has declined in recent decades in all age groups, particularly in old age. The age specific mortality rate of Thai population aged 60-64 decreased from 20.4 per 1,000 populations in 1960 to 13.4 in 2000. While the mortality rate for population aged 65-69 and 70 and over decreased from 27.3 and 61.7 in 1980 to 20.1 and 60.6 in 2000 respectively (Ministry of Public Health 2008). Based on these data, we see that the mortality rates in old age tend to increase with age.

Overall, the major causes of death among Thai elderly are non-communicable diseases including diabetes, heart diseases, cancer, kidney diseases and cerebrovascular diseases (Ministry of Public Health 2008). The mortality rates per 100,000 populations among the elderly Thai (aged 60 and over) by different diseases are shown in Figure 3.1. The results show that the mortality rate of elderly Thai caused by diabetes, cancer and cerebrovascular diseases increased during the mid 1990s to mid 2000s. All of these diseases are chronic diseases that not only cause death in old age but also affect their life courses before death. The increase in older people who suffer from these diseases before death might lead to the rise in health care needs and health expenditure in old age.

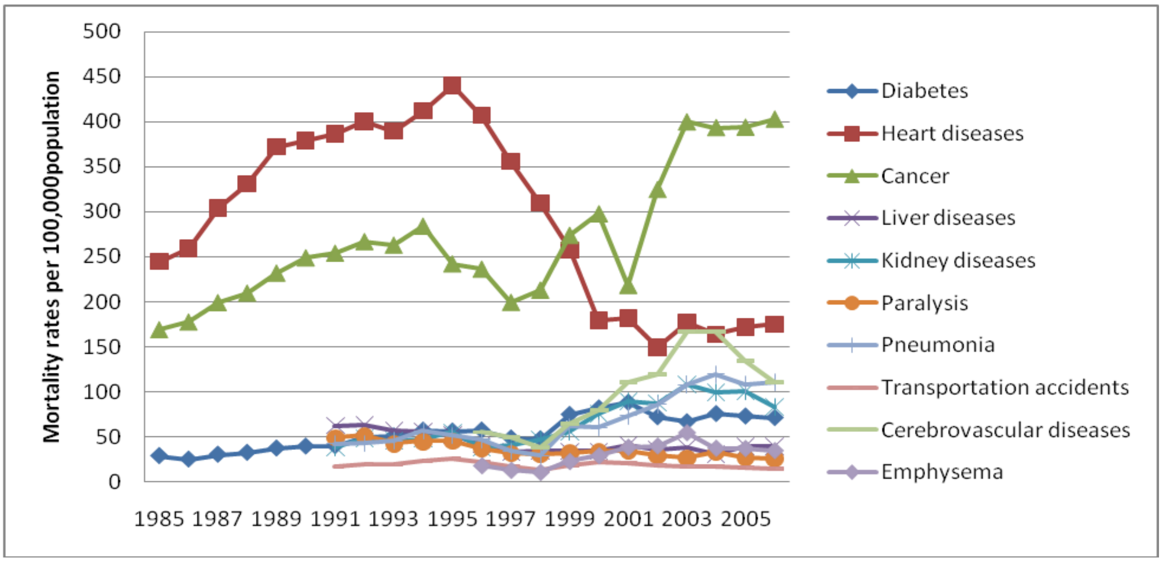


Figure 3.1: Mortality rates of major causes of death among the elderly Thai, 1985-2006
Source: Ministry of Public Health (2008)

3.4.2 Morbidity

In the past, the most common health problems for elderly Thai were infectious diseases that people experienced, that spread rapidly and killed large numbers of people or caused widespread illness (Ministry of Public Health 2008). Although great advances have been made in controlling these diseases through mass vaccination programmes, by improving the quality of water supplies and by providing better sanitation and drainage, infectious diseases are still a problem, with diseases such as malaria, or tuberculosis still causing many deaths. However, in recent years new types of health problems have become far more common in the majority of countries throughout the world. Non-infectious or non-communicable diseases are now becoming the main causes of death in many countries including Thailand and are affecting the quality of people’s lives. The common illnesses among the elderly Thai are hypertension, diabetes, joint diseases, asthma, and paresis (Ministry of Public Health 2008). These are diseases that affect older people. Although most of these diseases are not the major causes of death in old age Thai, they do lead to the limitation of activities in daily living. For example, the elderly who have joint diseases are likely to have difficulty in walking or bathing.

From a morbidity perspective, the National Survey of the Elderly in Thailand in 2002 reported the percentage of the common health problems among Thai older persons as shown in Table 3.7.

Table 3.7: Proportion (%) of Thai older persons (aged 60 and over) with most common diseases/symptoms by age, 2002

Disease/Symptom	**Age**				
	60-64	**65-69**	**70-74**	**75+**	**Total**
Body ache, back ache	72.7	74.7	77.8	77.3	75.1
Joint pain	42.8	46.7	49.8	54.9	47.5
Eye disease	27.5	31.1	37.3	42.8	33.2
Dementia	22.3	26.5	33.2	45.2	29.8
Hypertension	17.7	20.3	21.9	21.6	20.0

Source: (Ministry of Public Health 2008)

The results in Table 3.7 show that more than 70 percent of the population age 60 and over lived with body ache or back ache whereas 45 percent of elderly Thai age 75 and over had dementia. The percentage of elderly Thai who suffered from major diseases/symptoms tended to increase with age particularly for dementia and joint pain. The more years they live in old age means the more likely they are to live with these diseases. Moreover, the increase of elderly (especially the older old age population) will affect the health care needs and health spends.

3.4.3 Disability

Disability must be the centre of interest in a discussion about health status, particularly that of the older population. Diseases and health problems which affect performance in activities of daily living and increase dependence status deserve high priority for prevention or control strategies. Knowledge of disability status is essential for estimating the need for health and social care (Jitapunkul et al. 1993). Strokes, osteoarthritis of the knees, blindness (mainly from cataracts), and accidents and are among the high priority diseases/health problems of older Thais. The rapid ageing of society and the increase in the proportion of those suffering from chronic illnesses and disability is exerting substantial pressure on the demand for long-term care.

In Thailand, long-term disability and total disability as presented in Table 3.8 increase with age.

Table 3.8: Prevalence rates of total disability, long-term disability and dependency on self-care activities of daily living, Thailand, 1996-1997

	Long-term disability*	**Short-term disability***	**Total disability****	**Dependency in any self-care ADL*****
Age groups				
60-69	14.8	6.5	21.3	4.2
70-79	21.6	5.6	27.2	7.3
80+	32.9	4.5	37.4	19.1
Sex				
Male	17.4	4.6	22.0	5.7
Female	20.2	7.0	27.2	7.9
Reading ability				
Fluent	15.1	5.3	20.4	4.6
Not-fluent	22.5	7.8	30.3	6.9
Cannot	23.2	16.0	39.2	11.1
Area of living				
Urban	20.5	4.5	25.0	7.7
Rural	17.6	7.4	25.0	6.2
Financial problems				
Usually	25.5	9.1	34.6	9.6
Sometimes	20.8	8.1	28.9	7.4
Occasional	19.6	7.4	27.0	5.8
Never-rare	17.7	4.5	22.2	7.1

Source: Jitapunkul et al. (1999)

Notes: * is long-term disability is defined as having limitations in any activity for 6 months or longer.

** is total disability is defined as having long-term disability or having no long-term disability but short-term disability (recent limitation of activities due to current illnesses)

*** is self-care dependence is defined as in need of health or supervision in any self-care activity of daily living including feeding, grooming, transferring, toileting, dressing and bathing.

This trend is found in the dependency in any self-care activities in daily living which increases from 4.2 percent at ages 60-69 to 19.1 at ages 80 and over (Jitapunkul et al. 1999). The disability prevalence is different by gender. Older women have higher disability prevalence than older men in all age groups as presented in Table 3.9. Although elderly women live longer than elderly men, it appears they spend more years with disabilities. However, these data are based on only one single survey, which limits their value for projecting health trends in old age Thai in the future. It is important to study the trends in age-specific health status in old age (Jitapunkul et al. 1993).

Table 3.9: Long-term disability, total disability and dependency in self-care activities in Thailand (percentages), 1996-1997

	Male				**Female**			
	All	**60-69**	**70-79**	**80+**	**All**	**60-69**	**70-79**	**80+**
Long-term disability	17.4	14.6	19.4	27.6	20.2	14.9	23.4	36.0
Total disability	22.0	19.5	22.9	33.3	27.2	22.7	30.6	39.7
Self-care Dependence	5.7	4.0	5.4	16.1	7.9	4.4	8.9	20.9

Source: Jitapunkul et al. (1999)

3.4.4 Healthy Life Expectancy

The healthy life expectancy in Thailand is calculated based on the long-term disability and self care disability prevalence as presented in Table 3.10. As discussed above in Section 3.2, life expectancies in Thailand tend to increase and older women are expected to live longer than older men in the same age groups. At any given age women report poorer health than men at the older age. The healthy life expectancy in old age shows that older women tend to live longer than older men but they will spend more years than men with poor health or disability (Jitapunkul et al. 1999, Jitapunkul and Chayovan 2000).

Table 3.10: Ratio (per 100) of healthy life expectancy to total life expectancy by age and sex, Thailand, 1996-1997

Ages	**Male**			**Female**		
	LDFLE/LE	**TDFLE/LE**	**ALE/LE**	**LDFLE/LE**	**TDFLE/LE**	**ALE/LE**
60	80.8	76.1	91.9	76.1	69.7	89.2
65	78.9	74.5	90.5	73.1	67.1	87.1
70	77.1	72.6	89.1	70.1	64.6	84.9
75	75.5	70.6	87.4	67.4	62.2	82.4
80	72.4	66.7	82.2	64.0	60.3	79.1

Source: Jitapunkul et al. (1999)
Notes: LDFLE= long-term disability-free life expectancy; TDFLE= total disability-free life expectancy; ALE= active life expectancy; LE= life expectancy

The ratios between health expectancy and life expectancy shown in Table 3.10 demonstrate that Thai men have a proportionally longer healthy life than Thai women (Jitapunkul et al. 1999). The proportional time of disability for both men and women increases with age. Based on the healthy life expectancy trends, Thailand will face increasing demand for health care particularly the long term care and health expenditures because of the increase in old age women and oldest old in Thailand (Jitapunkul et al. 2003).

The healthy life expectancy in old age is important as the indicator for estimating the health care needs or health spends in later life (Jitapunkul and Chayovan 2000). However, the data on healthy life expectancy in Thailand is mainly reported for single year or specific periods due to the lack of time series of disability or health problem prevalence rates. It is important to investigate the temporal trend of healthy life expectancy in old age in the future so that appropriate elderly related policies, social security systems and health systems can be developed for a Thailand population that is ageing rapidly.

3.5 The Health Programme and Social Security for Elderly in Thailand

Before the 1st April 2001, the health system in Thailand was mainly the responsibility of the government. The Ministry of Public Health is the principal health care provider. Currently all government hospitals and health centres provide medical services for elderly (persons aged 60 or over) who registered for an elderly card in Thailand for free treatment under the medical care programme. Then since 2007, all government hospitals have clinics to provide specific care for the elderly. Moreover, because the increasing elderly population leads to increasing demand for quality health care provision for elderly, in 1992 the Ministry of Public Health created the Institute of Geriatric Medicine. The institute aims to develop and transfer new knowledge and technologies on gerontology (Ministry of Public Health 2008).

The available survey data on nursing homes and residential homes shows that less than 4,000 older persons are institutionalized for Long-Term Care (LTC) (Jitapunkul et al. 1999). In 2006, there were only 8 long-term institutional residences for the elderly, operated by central government. These provide services for the poor, the homeless and those who have no one to care for them. They also provide day care service to non-resident older persons who stay with their families. However, almost all older persons who need LTC received informal care provided by their families and relatives. The family remains an important source of support to the older persons, especially in the less developed regions where social security systems are generally less adequate. In effect, demographic ageing may lead to calls for more long-term care facilities (UNFPA 2006a, Jitapunkul et al. 1999).

In term of health care financing, most Thai people depend on their own resources to pay for their health. Before 1990, health care security was available only for government officers, state enterprise employees and the employees of the Red Cross Council. In 1990 the Social Security Act was established in Thailand to cover the enterprises with 20 or more employees. Moreover, from April 2002, the coverage has been extended to enterprises with one or more employees. In 1993, the government introduced the social assistance welfare scheme to cover the older persons who are aged 60 or over and children aged 0-5 years old. In 2000, 30 percent of the whole population was protected in health care by social or private insurance, 50 percent were under the social assistance welfare scheme and 20 percent lived without any health protection (Ministry of Public Health 2008). Then in 2001, in order to extend the health protection to the population which was not covered by any kinds of health benefit scheme, the universal coverage policy was established.

3.6 Discussion and Conclusions

Life expectancy improvement and fertility decreases led to population ageing in Thailand. Life expectancy at birth of males rose from 49.2 in the mid 1950s to 63.7 in the mid 2000s. The same trend was found for females as life expectancy at birth improved from 52.6 to 74.0 in the same period. Based on The World Population Prospects, the 2006 revision, life expectancy at birth for the Thai population was projected to continue to increase and reach 74.9 and 81.8 for males and females respectively in the next 50 years (United Nations 2006a). Both the estimates and the projections show that women live longer than men. The fertility rate for Thailand was forecasted to become stable at level lowers than 2. Based on these mortality and fertility trends, Thailand will face an increase in absolute number and percentage of the population who are aged 60 and over as presented in Section 3.2. The percentage of population aged 60 and over is projected to increase from 10 percent in 2000 to 30 percent in 2050 or three times within 50 years.

The population projection also showed an increase in the percentage of oldest old population who are aged 80 and over in Thailand. Not only will the number and percentage of the elderly increase but they are also expected to live longer. These trends lead to concern about consequences of population ageing particularly for health because older people tend to be more frails than younger persons. Older women are more likely to have poor health than men (Jitapunkul et al. 1999) because elderly women experienced lower levels of income, education and more widowhood than elderly men. The longer life of women might increase the demands on health, welfare and family support. Most elderly Thai live with their children and the children provide care for their elderly parents. However, the past decrease in the fertility rate will reduce the number of children available to care for future cohorts of the elderly.

The health status of elderly Thai is affected by the epidemiological transition as the major causes of death are now the non-communicable diseases (Ministry of Public Health 2008) as presented in Section 3.4. The proportion of elderly who suffer from chronic diseases increases with age, and this implies that the older people have a lower level of health status. Because of the increase in elderly people who live with chronic diseases and therefore disability in old age, the prevalence rates of disability were investigated in Thailand by measuring long-term disability, short-term disability, total disability and dependency in self-care activities (Jitapunkul et al. 1999 and Jitapunkul et al. 2003.). It was found that long-term disability and self-care disability increased with age and old age females had higher prevalence rates than males in all age groups as shown in Table 3.8 and 3.9.

Life expectancy free from disability in old age Thai was also analysed in order to examine the proportion of life expectancy spent free from disability. The proportion of life spent free from disability reduced with age in all types of disability. Elderly females spent more of their life in disability than elderly men. This implied that, although females are expected to live longer than males, they will spend more years in disability. However, studies on health status and healthy life expectancy in elderly Thai only referred to one point in time. There was a lack of data showing trends and change over time which are important in forecasting the future trends of health and demand on health care due to the ageing in Thailand. The comparison between different periods was limited. The next chapter will explore sources of data on health in Thailand which provides the ability to analyse changes in health status and future trends. The methodologies employed to investigate the variations in health in various ways are also discussed.

CHAPTER 4
RESEARCH RESOURCES AND METHODOLOGY

4.1 Introduction

This chapter focuses on sources of data used for studying the health status in old age and the demographic characteristics of elderly Thai, the population aged 60 and over in Thailand. Based on the aims of this study as presented in Chapter 1, the data sets used are from The Surveys of Elderly in Thailand conducted in 2002 and 2007 by The National Statistical Office (NSO), Thailand. The details of the surveys including the sampling techniques, sampling size and the questionnaires are described in Section 4.2. Because this study aims to analyse the health status in elderly Thai in different ways, then the health variables from the surveys will be studied using different techniques. We propose a study of health variation in old age and the impacts of place on health using multilevel models in Section 4.3. The concept of multilevel models and their algebra are reviewed and discussed. Section 4.4 presents the healthy life expectancy calculation methods, sources of information for the calculation of Thailand's healthy life expectancy and statistical test. Finally, the population projection method is discussed in Section 4.5 as part of the projection of health in old age in Thailand. Discussion and conclusions is presented in Section 4.6.

4.2 The 2002 and 2007 Surveys of the Elderly in Thailand

In order to examine the variations in the health status of elderly Thai and explore the relationship between demographic, socioeconomic characteristics, living conditions, living arrangement and health of elderly, The Surveys of Elderly in Thailand will be analysed. For Thailand, there are two cross sectional survey data sets related to elderly and health in Thailand. They are the Surveys of Elderly in Thailand 2002 and 2007 (NSO 2002, NSO 2008). Data from both of these surveys will be used in this research because they provide the variables that directly correspond with the research aims.

The key objective of these national surveys was to establish a nationally representative data base of demographic, socioeconomic, health characteristics and living arrangements of people aged 50 years and over in Thailand. The Surveys constitute nationally representative samples. To achieve this, the National Statistical Office adopted a stratified multi-stage sampling technique. The 76 provinces of Thailand were allocated to 76 strata and each of them was sub-divided according to administrative classification into urban and rural areas. The primary sampling units were blocks for municipal areas and villages for non-municipal areas. The probabilities of selection vary by the number of households residing in a block or village. In all, 5,796 blocks/villages and 5,793 blocks/villages were selected in 2002 and in 2007 respectively as shown in Table 4.1.

Table 4.1: The number of Primary Sampling Units (PSUs) in 2002 and 2007 Surveys of Elderly Thai

Regions	**Municipal Area**	**Non-municipal Area**	**Total**
Bangkok			
2002	312	-	312
2007	312	-	312
Central(excluding Bangkok)			
2002	1,080	888	1,968
2007	1,080	887	1,967
North			
2002	696	540	1,236
2007	696	540	1,236
Northeast			
2002	720	576	1,296
2007	720	576	1,296
South			
2002	528	456	984
2007	528	454	982
Whole Kingdom			
2002	3,336	2,460	5,796
2007	3,336	2,457	5,793

Source: NSO (2002 and 2008)

The secondary sampling units were private households. For the municipal area, 15 households containing a person aged 50 years or older were selected systematically from each selected block and for the non-municipal area; 12 households were selected systematically from each village. Therefore, 79,560 households and 79,542 households were selected for final sample in 2002 and 2007 respectively as shown in Table 4.2. The total number of elderly aged 60 and over who were interviewed in the 2002 and 2007 Surveys of Elderly Thai were 24,835 and 30,427 respectively (NSO 2002, NSO 2008).

Table 4.2: The number of private households in 2002 and 2007 Surveys of Elderly Thai

Regions	Municipal Area	Non-municipal Area	Total
Bangkok			
2002	4,680	-	4,680
2007	4,680	-	4,680
Central (excluding Bangkok)	16,200	10,656	26,856
2002	16,200	10,644	26,844
2007			
North			
2002	10,440	6,480	16,920
2007	10,440	6,480	16,920
Northeast			
2002	10,800	6,912	17,712
2007	10,800	6,912	17,712
South			
2002	7,920	5,472	13,392
2007	7,920	5,448	13,368
Whole Kingdom			
2002	50,040	29,520	79,560
2007	50,040	29,484	79,524

Source: NSO (2002 and 2008)

The Survey of Elderly in Thailand covered a variety of demographic, socio-economic, health characteristics and living arrangements of people age 60 years and over in Thailand. The content of the questionnaire is divided into:

- Demographic and socio-economic characteristics such as age, gender, marital status, education, number of children, income, source of income, and reasons for not working.
- Health status which covered self-rated health and problems with activities in daily living.

- Living conditions such as type of living quarter, type and location of toilet, location of bedroom and owner of dwelling.
- Living arrangement such as co-residence and contact with spouse, children and relatives, visits and material exchanges from children and others.

The health variables from The Surveys of Elderly in Thailand are obtained from the self-rated health questions. There are two key questions which related to health status. Question A asks about general physical health and question B asks about ability to perform activities in daily living as presented in Table 4.3 below. Items in bold differ between the two surveys.

Table 4.3: Questions on health from the 2002 and 2007 Surveys of Elderly in Thailand

2002	**2007**
Question A: How is your physical health in the past 7 days? a) very good b) good c) fair d) bad e) very bad	Question A: How is your physical health in the past 7 days? a) very good b) good c) fair d) bad e) very bad
Question B: Can you perform these activities by yourself ***(no, yes)***? • Feeding • Dressing • Bathing/Toileting • Squatting • Carrying thing 5 kgs • **Walking 1 km** • Climbing stair 2-3 flights • Taking a bus/ship alone	Question B: Can you perform these activities by yourself ***(no, yes with aids, yes without aids)***? • Feeding • Dressing • Bathing/Toileting • Squatting • Carrying thing 5 kgs • **Walking 200-300 m** • Climbing stair 2-3 flights • Taking a bus/ship alone • **Calculating and using money correctly**

Source: NSO (2002 and 2008)

Based on the questions on health of the elderly in Thailand shown in Table 4.3, The Surveys of Elderly Thai provide the ability to measure the health status of the elderly based on self-rated health and activities in daily living. Self-rated health is a key indicator on health in old age which relates to diseases and mortality in old age as discussed in Chapter 2. The ability to perform activities in daily living is also reported as a key indicator for disability in old age which is strongly related with the demand for long-term care. These health variables will be useful in the study of health status, and variation of health in old age Thai. Moreover, because the surveys contain nearly the same questions on health then the availability of two cross-sectional data sets potentially provides the ability to measure the differences of health between two points of time although caution will need to be exercised. This will help us to project health in the future and to relate projected health to the future and health expenditure and health care needs which will be presented in Chapters 6, 7 and 8.

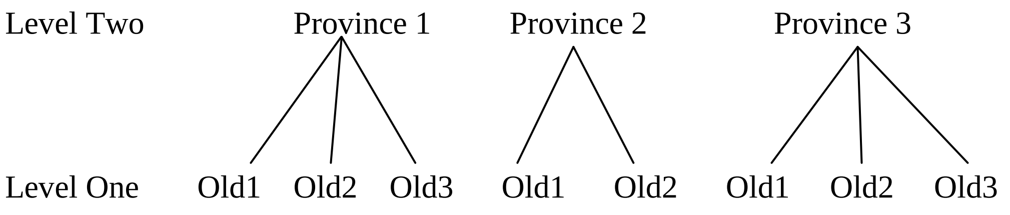
4.3 Data Analysis: Descriptive Analysis and Multilevel Modelling

The Survey of Elderly in Thailand will be analysed using the statistical package SPSS version 15 for Windows and MLwiN, a multilevel modelling package. Analysis for health variation in old age will include descriptive analysis and multilevel modelling. The descriptive analysis will give an overview of the data such as the demographic and socio-economic characteristics of the elderly. The analysis also presents the general pattern of health of the elderly. Multilevel analysis will be applied in the analysis of variation in health by area. Multilevel modelling is a methodology for the analysis of data with complex patterns of variability. Multilevel analysis takes account of the variability associated with each level of nesting. The individual and the context are distinct sources of variability and should both be modelled (Snijders and Bosker 1999).

Multilevel models are developed for analysing hierarchical data which contains individuals nested in groups. The structure of hierarchical data is defined as individuals within various types of groups. There are variables describing individuals as well as variables describing groups (Kreft and Leeuw 1998). To analyse these data at different levels of hierarchy simultaneously, multilevel models are applied.

The hierarchical structure of the data as presented in Figure 4.1 is commonly used in variety of research areas. For example, to study the achievement of students, data will be collected on students in different schools. In this example, the students are level one, micro level or individual level in the model whereas schools are level two or macro level or group level. However, data can be collected from more than two levels. For instance, elderly people are nested within villages which are nested within provinces. Then the influence of more levels can be analysed using multilevel models.

Two Levels Structure: Provinces are level two and Old people are level one



Three Levels Structure: Provinces are level three, Villages are level two and Old people are level one

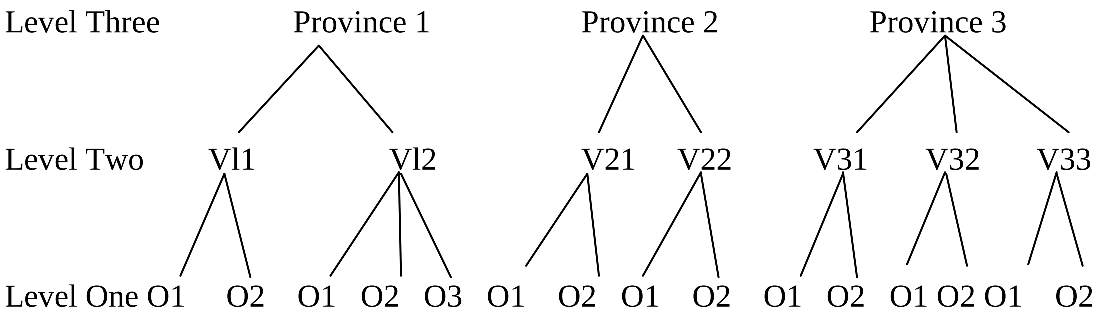


Figure 4.1: Hierarchical structure data for two and three levels data

The advantages of the multilevel models are not only the ability to model the data with a complex structure such as two or more levels but also the ability to measure heterogeneity by measuring the variances whereas the standard regression approach models the averages (Snijders and Bosker 1999). The multilevel models can model the complex dependencies in the outcome over time or over contexts.

The multilevel models can divided broadly into three types: the variance components model or null model, the random intercepts model and the random slopes model.

Variance Components Model is the simplest case of the hierarchical linear model where the explanatory x is not taken into account. It contains only random groups and random variation within groups as presented in Equation 4.1:

$$y_{ij} \quad = \quad \beta_{00}+\mu_j+\varepsilon_{ij} \tag{4.1}$$

where

y_{ij}	is the response y for the *i*th individual in the *j*th group is the (and assumed here to be a continuous variable)
β_{00}	is the overall mean of y across all groups
$\beta_{00}+\mu_{0j}$	is the mean of y for group j
μ_j	is the difference between group j's mean and the overall mean
ε_i	is the difference between the y-value for the *i*th individual and that individual's group mean

This model is important because it shows the basic variability in the data between two levels (Snijders and Bosker 1999).

The Random Intercepts Model is developed by allowing the intercept of single level regression model, β_0 (Equation 4.2) to vary from group to group (Snijders and Bosker 1999, Duncan et al. 1998) as presented in Equation 4.3.

The single level regression model is

$$y_i \quad = \quad \beta_0+\beta_1 x_{1i}+\varepsilon_i \qquad (4.2)$$

where

y_i is the response/dependent variable

x_{1i} is the explanatory variable

β_0 is the mean of y

β_1 is the change in y for a one unit change in x

ε_i is the difference between the y-value and the mean

Allowing β_0 to vary from group to group and taking into account the group effect then results in

$$y_{ij} \quad = \quad \beta_{0j}+\beta_1 x_{1ij}+\varepsilon_{ij} \qquad (4.3)$$

where

y_{ij} is the value of y for the *i*th individual in the *j*th group

β_{0j} is the overall mean of y across all groups

β_1 is the change in y for a one unit change in x

ε_{ij} is the difference between the y-value for the *i*th individual and that individual's group mean

The coefficient β_{0j}, dependent on group j, can be divided into the average intercept and the group dependent deviation (Snijders and Bosker 1999) as shown in Equation 4.4.

$$\beta_{0j} \quad = \quad \beta_{00} +\mu_{0j} \qquad (4.4)$$

where

β_{00} is the overall mean of y across all groups

μ_{0j} is the difference between group j's mean and the overall mean

Substitution for β_{0j} in Equation 4.3 by the right hand side of Equation 4.4 lead to the random intercepts model as presented in Equation 4.5.

The random intercepts model is as follows:

$$y_{ij} = \beta_{00}+\beta_1 x_{1ij}+ \mu_{0j} +\varepsilon_{ij} \quad (4.5)$$

where

i is the index for individuals within groups ($i=1,2,3,...,n_j$)

j is the index for groups ($j=1,2,3,...,N$)

y_{ij} is the response for the i^{th} individual in j^{th} group

β_{00} is the overall mean of y across all groups

β_1 is the change in y for a one unit change in x

μ_{0j} is the difference between group j's mean and the overall mean (the group dependent deviation)

ε_{ij} is the difference between the y-value for the *i*th individual and that individual's group mean

Then some groups tend to have a higher average responses y whereas the other groups tend to have lower responses in the random intercepts model. However, β_1 or regression coefficient of explanatory x_1 is assumed to be constant in the random intercepts model.

The single level regression as presented in Equation 4.2 is the ordinary least squares or fixed effect model which does not take into account the hierarchical structure.

Then it can produce the wrong answer when applied to data that has nested structure (Snijders and Bosker 1999, Duncan et al. 1998).

The random intercepts model contains two model parts, that is, the fixed part or "$\beta_{00}+\beta_1 x_{1ij}$" and the random part or "$\mu_{0j}+\varepsilon_{ij}$". The intercept for the overall regression is β_{00} the same as in the single regression model but the random intercept model also takes into account the group effect then each group has its own regression line which is parallel to the overall average line ($\beta_{00}+\beta_1 x_{1ij}$). The intercept for each group is $\beta_{00}+\mu_{0j}$. Because the intercept of each group contains the random part (μ_{0j}) which allowed variations between groups, then it is called the random intercepts model.

The parameters which are estimated from the fixed part are the coefficients (β_{00}, β_1) and from the random part are the variances (δ^2_μ, δ^2_ε). δ^2_μ is the between group variance and δ^2_ε is the within group variance. Total variance then equals $\delta^2_\mu+\delta^2_\varepsilon$ (Kreft and Leeuw 1998).

The random slopes model is the multilevel model that allows the intercepts and slopes to vary randomly. In the random intercepts model the group differences are measured by the average value of the dependent variables and the random group effect is only captured in the random intercept (μ_{0j}), while in the random slopes model the relation between explanatory and dependent variable are allowed to vary between groups. The equation for the random slopes model is presented in Equation 4.6:

$$y_{ij} = \beta_{00}+\beta_{1j}x_{1ij}+\mu_{0j}+\varepsilon_{ij} \quad (4.6)$$

where, β_{1j} is the regression coefficient or slope which depends on group j and can be decomposed thus:

$$\beta_{1j} = \beta_{10}+\mu_{1j} \quad (4.7).$$

If we substitute the right hand side of Equation 4.7 into Equation 4.6, we then obtain:

$$y_{ij} = \beta_{00}+\beta_{10}x_{1ij}+ \mu_{0j}+ \mu_{1j}\, x_{1ij} +\varepsilon_{ij} \qquad (4.8).$$

As in the case of Equation 4.5, two variances are estimated ($\delta^2_{\mu 0}$ and δ^2_{ε}); but now additionally there is a further variance term ($\delta^2_{\mu 1}$) associated with explanatory variable x_1; and also co-variance terms for x_0 and x_1 ($\delta_{\mu 0\ \mu 1}$).

In terms of statistical significance testing, whilst the 'pseudo-Z test' where the ratio of a model estimate to its associated standard error can be used (for judging significance for terms either the fixed or random part of the model) [2] the Wald test is preferred in the literature (Jones 1991, Rashbash et al. 2004, Harrell 2001, Gould and Fieldhouse 1997). The Wald test simply uses a chi-square test to compare in the case of Equation 4.8 whether the:

1) level-1 fixed part estimates are significantly different from zero;
2) level-1 variance is significantly different from zero;
3) level-2 variances and co-variances (random part contrasts) are significantly different (i.e. to test whether there are significant differences between level-2 place variances).

4.4 Healthy Life Expectancy Calculation: Thailand Life Table

In order to investigate the effects of health status on the life expectancy of elderly Thai, healthy life expectancy will be calculated. Healthy life expectancy summarises the expected number of years to be lived in "full health". Healthy life expectancy also provides a measure of overall level of health for the population in a way that is appropriately sensitive to probabilities of survival and death and to the prevalence and severity of health states among the population. Two different types of method have been used for calculating healthy life expectancy: the Sullivan method and the multistate life table method (Jagger et al. 2007, Breakwell and Bajekal 2006, Murray and Lopez 1997). In this research, the Sullivan method will be applied. This method involves using the prevalence of disability at each age in the population at a given

[2] Ratio of greater than two are normally deemed significant.

point of time to divide the years of life lived by a period life table at different ages into years with good or poor health. The prevalence rate of poor health or disability in older age (calculated from the Survey of Elderly in Thailand) will be used. However, to calculate healthy life expectancy, a population life table is also required. A life table is built up from a set of age-specific death rates which can be defined as the number of deaths occurring in a given period at age x divided by the size of the mid-year population at age x. In Thailand, The Ministry of Public Health provides the mid-year population number and the numbers of deaths based on the Thailand Vital Registration organised by the Department of Provincial Administration, Ministry of Interior, which records all deaths occurring in the population and issues a death certificate.

The United Nations also provides the mid-year population estimates and number of deaths for the Thai population. The World Health Organization also produces annual life tables for all member states between 2000 and 2004. These life tables have several uses and form the basis of all WHO estimates about mortality patterns and level worldwide (World Health Organisation 2004).

To calculate healthy life expectancy at a particular age and time, it is necessary to calculate the number of person years lived in the health state from that age at the particular time. Thus, theoretically, estimates of healthy life expectancies at this time depend on the incidence of the healthy state and are essentially cohort measures (Jagger et al. 2007, Mathers and Robine 1997). Direct calculation of the person years lived in the health state requires longitudinal data (which is not readily available in many contexts including Thailand) or using the estimates of transition matrices (Khoman et al. 2008) to obtain the transitional rate between health states (this is the multistate method). The Sullivan method is of particular practical importance as it uses more readily available data: age-specific prevalence of the health states and the total person years lived at a particular age. Obviously some errors are associated with this approximation (except if all population characteristics are stable in time) but many researchers have shown that the Sullivan method can, generally be recommended for its simplicity, relative accuracy and ease of interpretation (Jagger et al. 2007, Mathers and Robine 1997, Bebbington 1988). The Sullivan method is considered in the next section and is followed by consideration of the multistate method.

4.4.1 The Sullivan Method for Calculating Healthy Life Expectancy

This calculates healthy life expectancy as the number of remaining years, at a given age, which an individual can expect to live in a healthy state. This Sullivan method provides a means of comparing the health states of an entire population at two time points or two different populations at the same time point, despite differences in age composition (Jagger et al. 2007). However, the same definition of health states and age intervals must be used for the populations and/or time point being compared. The data required are the age-specific prevalence of the population in healthy and unhealthy states, and age-specific mortality information taken from a period life table. The measure is not sensitive to the size of the age groups, and an abridged life table can be used (Jagger et al. 2007).

The difference in healthy life expectancy between two points in time can be tested by using the Z-statistic (Jagger et al. 2007). This test is based on the assumption that the estimates of healthy life expectancies have normal distributions. The two healthy life expectancies and their standard errors (or variances) are needed as shown in Equation 4.9.

$$Z = \frac{HLE_1 - HLE_2}{S(HLE_1) + S(HLE_2)} \tag{4.9}$$

where

Z = the Z-score

HLE_1 = the healthy life expectancy at time 1

HLE_2 = the healthy life expectancy at time 2

S (HLE_1) = the standard error of healthy life expectancy at time 1

S (HLE_2) = the standard error of healthy life expectancy at time 2

The hypothesis of equality of healthy life expectancies between two times is rejected if the absolute value of the Z-score is greater or equal 1.96 (5% level) (Jagger et al. 2007).

4.4.2 Multistate Method for Calculating Healthy Life Expectancy

Some authors have claimed that the Sullivan method produces biased or incorrect estimates and cannot be used to monitor healthy life expectancies of populations over time. Because the Sullivan method uses the age-specific prevalence of health states in a population at a particular time to calculate the years of life lived in the various health states at each age by a period life table, it cannot detect a sudden change in health transition rates (Mathers and Robine 1997).

Multistate methods were proposed by Rogers et al. (1990) to take into account reversible transitions between good health and other health states. Moreover, the multistate method allows one to calculate health expectancies for population subgroups in a specific health state at a particular age, whereas the Sullivan method gives only the average health expectancy for the entire population at a particular age. The prevalence rate used in the Sullivan method reflects the past experience of each cohort (stock dependent on past history) and not the current incidence rates (flow dependent) which can be used to calculate a pure proportion of unhealthy people (Mathers and Robine 1997).

The multistate method is to be preferred for computing healthy life expectancies, but it requires information on transitions between health states (longitudinal data) which are expensive, time consuming to collect and rarely available (Jagger et al. 2007, Crimmins et al. 1994). Although longitudinal data are the best data which measure health transitions surveys using current and retrospective questions about disability could also be used in this case.

Mathers and Robine (1997) have developed the concept of the transition between health states which they used to calculate disability free life-expectancy (DFLE) by considering a two state life table with a non-disabled state and disabled state (see Figure 4.2). This study also shows that the multistate method generalizes the single state life table to include reversible transitions between two or more non-absorbing alive states.

From Figure 4.2, l_{xk} is the number of survivors in state k (k = 1, 2) and age x. The transition probability i_x is the probability of a person not disabled at exact age x being disabled at exact age x+5, which is closely related to the incidence rate of disability for the age interval (x, x+5). The transition probability r_x is the probability of a person disabled at exact age x being free of disability at exact age x+5, which is closely related to the recovery rate from disability for the age interval (x, x+5). The transition rates q_{x1} and q_{x2} are the probabilities of dying within the interval age (x, x+5) for a non-disabled and disabled person respectively.

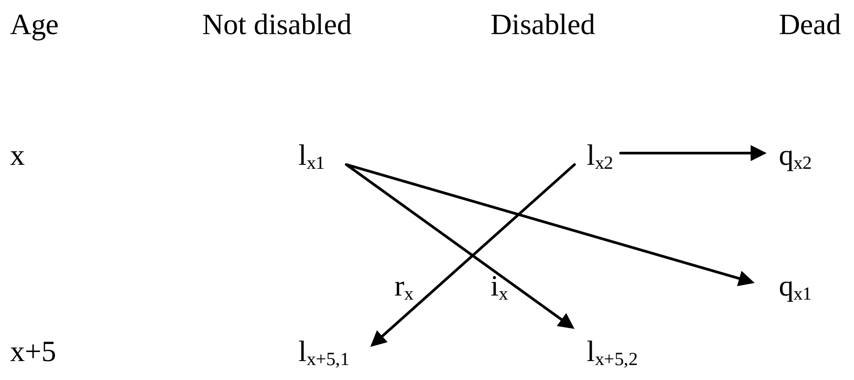


Figure 4.2: Transitions in the multistate method
Source: Mathers and Robine (1997)

The Sullivan and multistate methods produce similar results providing all transition rates are smooth and regular over time (Mathers and Robine 1997). When prevalence remains the same between two periods, but the incidence rate between states of health change rapidly, then the Sullivan method may underestimate or overestimate health expectancy, because the prevalence of ill health at a given age in the population reflects the past probabilities of becoming ill at each younger age. Differences between the multistate and Sullivan indicators also occur if prevalence changes while incidence remains constant (Jagger et al. 2007) as cohort replacement occurs.

4.4.3 Classification of Healthy Life Expectancy

The classification of healthy life expectancy change in old age into the classes “compression”, “expansion” and “dynamic equilibrium” is dependent on the relationship between total life expectancy and morbidity/disability free life expectancy, particularly when the total life expectancy increases. If the total life expectancy is fixed, a rise of morbidity/disability free life expectancy automatically implies compression of morbidity/disability and a decrease in morbidity/disability free life expectancy means expansion of morbidity/disability occurs.

However, an increase (not fixed) in total life expectancy can lead to constant, decreasing or increasing healthy and unhealthy life years. The assessment of health trends in extra life years gained then should be classified as absolute or relative compression/expansion/equilibrium (Nuesselder 2003, Van Oyen et al. 2008).

Absolute expansion is defined as an increase of unhealthy life years and absolute compression refers to a decrease of unhealthy life years. Relative expansion or compression is defined monitoring the change in healthy life expectancy. We present the typology in Table 4.4

Table 4.4: A typology of healthy life expectancy changes

LE	**HLE**	**UHLE**	**HLE/LE (%)**	**Classification**	
				Absolute	**Relative**
↑	↑	↓	↑	Compression	Compression
↑	↑	=	↑	Equilibrium	Compression
↑	↑	↑	↑	Expansion	Compression
↑	↑	↑	=	Expansion	Equilibrium
↑	↑	↑	↓	Expansion	Expansion
↑	=	↑	↓	Expansion	Expansion
↑	↓	↑	↓	Expansion	Expansion

Source: Van Oyen et al. (2008)
Notes: LE = Life Expectancy, HLE = Healthy Life Expectancy, UHLE = Unhealthy Life Expectancy, Compression = Compression of Morbidity, Expansion = Expansion of Morbidity, Equilibrium = Constant Morbidity

4.5 Population Projections and Health Projections

To better understand the demographic dynamics affecting elderly population in Thailand, population projections will be undertaken and analyzed in this research. The population projections are calculations of future population numbers under specified assumptions about change in population growth or it components.

The population and housing census in Thailand is one of the most important sources of socio-economic data in the country. It provides the most comprehensive information on the population in terms of their demographic and social conditions as well as the housing conditions at the national and sub-national level: region, province, district, sub-district and village levels. Population and Housing Census in Thailand is undertaken every 10 years. The latest census was carried in 2000.

The population projection is an important use of the population and housing census data. In Thailand, the National Economic and Social Development Board (NESDB), the National Statistical Office, Ministry of Information and Communication Technology was set up to carry out population projections. The latest one is the Thai Population Projection 2000-2025 which contained 3 series with variations in fertility assumptions i.e. medium, high and low level. The assumption on mortality was set as a constant and the migration assumption was set as no international migration. The base population used was the number of people by age and sex from the 2000 Population and Housing Census (NESDB 2003).

The other source of population projections for Thailand is the United Nations which provides projections based on the assumptions regarding the derivation of demographic indicators of the period starting in 2005 and ending in 2050 (United Nations 2006b). The results from population projections which came from different sources with different assumptions will be compared. However, a new Thailand population projection will be developed by introducing assumptions about international migration and also expanding the period of projection from 2025 to 2050 as projected by the United Nations. This new set of population projections will be used to investigate the effect of the migration assumption on population change and also compare the projected population with the result from United Nation population projection for Thailand.

To explore the health status of elderly in the future, the population projections will be combined with the health change in old age based on the Surveys of Elderly in Thailand 2002 and 2007 from Chapter 6. The three morbidity assumptions are applied to project trends of health in old age Thai and discussed later in Chapter 7.

4.6 Discussion and Conclusions

The 2002 and 2007 Surveys of Elderly in Thailand are the key sources of national data on the health status of old age Thai. They provide the health data based on self-rated health and activities in daily living which represent general health and disability in old age. Although these are cross-sectional surveys, they contain almost the same questions which provide the possibility for monitoring change in health trends. The surveys also contain the variables on demographic, socioeconomic and living arrangement of elderly which are needed to investigate the relationship of these variables with health. The Surveys of Elderly in Thailand adopted stratified multi-stage sampling. The data are hierarchical in structure with individuals nested in primary sampling units and provinces. To investigate the variation of health by geographical area, demographic characteristics, socioeconomic characteristics and living arrangement, multilevel models are employed because they allow the dependent variable (health) to vary between different levels (areas of residence) simultaneously. There are three types of multilevel model that are applied to investigate the variation of health by areas of residence in Chapter 5 including null model, random intercept model and random slope model.

In order to investigate the variation of healthy life expectancy for elderly in Thailand between 2002 and 2007, the healthy life expectancy calculation methods were discussed in this chapter. There are two key methods including the Sullivan method and the multistate method. The Sullivan method calculates healthy life expectancy based on health prevalence rates. Whereas the multistate method calculates using the health incidence rate and allows the transition between health states. Because the health data for Thailand are available only as prevalence rates then the Sullivan method is applied for calculating healthy life expectancy. To calculate healthy life expectancy, the persons years live which derived from life table are needed. The population projection and health projection models are also proposed as the key methods for projecting the future number of old age and the number of old age with different health states. The results of variations of health by different geographical areas are explored in the next chapter, Chapter 5, while healthy life expectancy based on the Sullivan method using different health indicators is estimated in Chapter 6. The Thailand population projection and health projection are implemented and discussed in Chapter 7.

However, health data in Thailand could be improved by repeating the Survey of Elderly in Thailand. A good time series of surveys can provide reliable trends in health, which is very important for developing health policy and plans for the future. It is important that the repeating survey must ask the questions on health as the previous surveys. Moreover, Thailand would be benefit from the development of longitudinal panel study with questions on health status so that the transition between health states can be measured, making it possible to calculate healthy life expectancy by multistate methods.

CHAPTER 5
ELDERLY HEALTH STATUS AND HEALTH VARIATIONS

5.1 Introduction

The increase in the number and the proportion of elderly leads to the concern about their health status. However, the studies show that health status in old age varied due to their demographic and socioeconomic characteristics. Moreover, the variations of elderly characteristics and contexts between places can cause health inequality. Different places will need different responses to demand for health care services or health policy. This chapter therefore aims to describe the demographic and socioeconomic characteristics of elderly population in Thailand based on The Surveys of Elderly in Thailand in 2002 and 2007 as presented in Section 5.2. Then, the relationship between elderly characteristics and health status of elderly Thai is explored in Section 5.3 using the Survey of Elderly in Thailand 2007. This section also investigates the variations of health between areas including provinces and local areas of residence (Primary Sampling Unit, PSUs) using multilevel modelling. Finally, findings are discussed and conclusions are presented in Section 5.4.

5.2 Demographic and Socioeconomic Characteristics of Elderly Thai

A statistical summary of demographic and socioeconomic characteristics of elderly Thai is presented in Table 5.1. The results show that more than 50 percent of elderly Thai were under age 70 in 2002 and 2007. However, the proportion of elderly age 60-69 decreased from 57 percent in 2002 to 53 percent in 2007, while the proportion of elderly aged 70-79 and 80+ increased. The percentage of elderly aged 70-79 rose between 2002 and 2007 from 31.4 to 34.0 and the percentage of elderly age 80+ rose from 11.7 to 13.0 in the same period. This shows that the old age Thai are growing older.

Table 5.1: Demographic and socioeconomic characteristics of Thai elderly in 2002 and 2007

	2002 % (absolute number)				2007 % (absolute number)			
	60-69	**70-79**	**80+**	**Total**	**60-69**	**70-79**	**80+**	**Total**
Total	57.0(14,145)	31.4(7,796)	11.7(2,894)	100.0 (24,835)	53.0(16,131)	34.0(10,355)	13.0(3,941)	100.0 (30,427)
Gender								
Male	45.5	42.6	37.1	43.6	45.3	41.3	38.0	43.0
Female	54.5	57.4	62.9	56.4	54.7	58.7	62.0	57.0
Marital Status								
Married	71.1	55.5	32.7	61.8	70.1	53.3*	30.9	59.3
Single	3.7	2.8	2.0	3.3	4.3	3.1	2.3	3.6
Widowed	23.0	40.2	64.8	33.1	22.6	41.7	65.4	34.6
Divorced/Separated	2.2	1.5	0.5	1.8	3.0*	1.9	1.4*	2.5
Education								
Primary School	75.9	72.3	48.2	71.5	73.4*	72.8	55.7*	70.9
Secondary/beyond	9.1	6.5	3.9	7.7	15.7*	7.7*	6.6*	11.8
No Education	15.0	21.1	47.9	20.7	10.9*	19.5	37.7*	17.3
Living Arrangement								
Live alone	6.2	8.6	8.9	7.3	7.1	9.7	10.4	8.4
Live with other	93.8	91.4	91.1	92.7	92.9	90.3	89.6	91.6
Working Status								
Worked Previous Week	44.2	17.5	4.6	31.2	49.1*	22.4*	7.3*	34.6
Not Worked	55.8	82.5	95.4	68.8	50.9*	77.6*	92.7*	65.4
Housing Tenure								
Elderly/Spouse own	85.8	79	59.8	80.6	83.9*	77.2*	59.0	78.4
Children own	5.7	13.4	27.2	10.6	7.6*	16.3*	31.5*	13.6
Others own	8.5	7.6	13	8.7	8.5	6.5	9.5*	8.0

Source: Author's calculation.
Note: * is statistically significant difference at 5% level (chi-square test)

Among the elderly, the number of elderly women was higher than men in all age groups. More than 50 percent of elderly in all age groups were women and the proportion of women increased with age both in 2002 and 2007. This might be the results of the difference in life expectancy in old age Thai between men and women. Elderly women lived longer than men so the impacts of different gender on health status and socioeconomic characteristics of old age need to be considered. This is because Thai elderly women reported in a United Nations survey (UNFPA 2006a) that they are more likely to have lower level of literacy, a higher percentage of being single and living alone with low income and a lower level of participating in labour force. They have lower likelihood of receiving formal retirement benefits or social support than elderly men. Moreover, the higher level of morbidity and disability are found in elderly women than men. The results regarding marital status show not surprisingly that the younger age group of elderly was more likely to be married whereas the older tend to be widowed. However, when we look at trends in marital status in old age between 2002 and 2007, the results show that there are small changes- married 2.5 percent lower, single 0.3 percent higher, widowed 1.5 percent higher, divorced/separated 0.7 percent higher, in marital status of elderly Thai between this period.

The education level in old age Thai can be divided into broadly three groups including elderly who graduated primary school, secondary school and beyond and finally elderly with no education. More than 80 percent of elderly Thai graduated from primary school or secondary school and beyond and that means less than 20 percent had no education. The high proportion with no education was found in oldest old both in 2002 and 2007. The comparison of educational level between 2002 and 2007 show that the proportion of elderly who had no education and who graduated from primary school only tended to reduce whereas the proportion of elderly who graduated from secondary school and beyond tended to increase. This suggests that the education level of future generations of old age Thai will be improved, though a projection of the population by educational status would be needed to confirm this. The percentage of elderly who lived alone was 10 or less because older Thai preferred to live with a spouse or with children rather than living alone.

The economic characteristics based on working status in the previous week before the survey and housing tenure was explored in the Survey of Elderly in Thailand. Although the elderly age 60-69 who worked in the previous week was less than 50 percent both in 2002 and 2007 the trend show an increased from 44.2 percent in 2002 to 49.1 percent in 2007. The proportion of elderly age 70-79 and 80+ who worked also increased between 2002 and 2007. The proportion of elderly age 70-79 rose from 17.5 percent to 22.4 percent while the proportion for elderly age 80+ rose from 4.6 percent to 7.3 percent. This is an encouraging trend because future population ageing will require increased labour force participation of older people to maintain their incomes. The results on housing tenure in old age Thai showed that mainly they lived in their owned houses or houses own by their spouse which account for 80.6 percent in 2002 and 78.4 percent in 2007. However, the proportion of elderly who live in their children's house increased as they get older.

5.3 Health Status and Health Variation Analysis Using Multilevel Models

Researchers have shown increasing interest in the simultaneous consideration of the impact of individual and contextual variations on health outcomes, health related behaviour and health service performance (Duncan et al. 1998, Gould 2010, Langford et al. 1999). This study will investigate compositional context sources of variations in elderly health. Multilevel modelling techniques are applied to the health survey data to explore variations in self-reported levels of activities in daily living (ADL) for elderly Thai people which divided into self-care activities and mobility activities. Self-care activities include feeding, dressing and bathing/using toilet while mobility activities contain squatting, climbing 2-3 stairs, lifting 5kg and taking public transport. The multilevel modelling presented in this chapter is done using the cross-sectional Survey of Elderly in Thailand 2007. The ability to perform self-care activities has been captured in an overall index of three activities and combined in an overall four points scale index (0-3) designed by the author. The ability to perform mobility activities is based on an overall five points scale index (0-4). In the multilevel statistical models to be presented below the probabilities of reported total or all 3 activities (high performance) for self-care activities and all 4 activities for mobility activities are modelled as the response variables. The explanatory variables are shown in Table 5.2 and the logit transform for the respondent variables are shown in Table 5.3

The data from The Survey of Elderly in Thailand 2007 has a hierarchical in structure with the individual (elderly aged 60 and over) nested in residence block (Primary Sampling Units, PSUs) drawn from provinces (NSO 2008). There were 30,427 elderly respondents drawn from 4,366 residence blocks within 76 provinces. The presentation of results begins by considering first the 'null' variance component model which includes no predictor variables, then follows by employing a random intercepts model that includes level-1 individual predictors (e.g. age group, gender, education and living arrangement) before finally exploring the complex variability with random slopes (this is done for age and education). In summary there are sets of models for two different response variables. The next section elaborates on the equation specification of the multilevel models as discussed in Chapter 4, Section 4.3.

Table 5.2: Variables and categories used in multilevel modelling

Variables	Categories
Response variables	
Self-care activities	The probabilities of reports 3 activities
Mobility activities	The probabilities of reports 4 activities
Predictor variables	
Age group	60-69 (base category)
	70-79
	80+
Gender	Female (base category)
	Male
Education	Primary school (base category)
	Secondary school and beyond
	No education
Worked last week	Did not work (base category)
	Worked
Housing Tenure	Elderly/spouse own (base category)
	Children own
	Others own
Living Arrangement	Live with others (base category)
	Live alone

5.3.1 Specifying Multilevel Models

The discussion here considers the specification of two examples of multilevel models that were actually estimated and the results are discussed later. To simplify the presentation this considers just one of the response variables (probabilities of reported total self-care activities), that is Model 2 to be presented later in Subsection

5.3.2 (see below). Beginning first with the specification of a random intercepts model that includes a number of predictor variables and has with individuals (level one) nested in PSUs (level two) and provinces (level three), we can write a three-level multilevel model:

Table 5.3: The calculation of respondent variables from ordinal scale to logit scale and logit transform

	Number of Self-care Activities	**Proportion of Activities**	**Odds (p/1-p)**	**Logit (ln odds)**	**Logit to Odds (e^x)**	**Odds to proportion ($e^x/(1+e^x)$)**
Self-care	0	0/3 = 0.000	0.000001	-13.816	0.000001	0.000
	1	1/3 = 0.333	0.499250	-0.695	0.499250	0.333
	2	2/3 = 0.667	2.003003	0.695	2.003003	0.667
	3	3/3 = 0.999	999	6.907	999	0.999
Mobility	0	0/4 = 0.000	0.000001	-13.816	0.000001	0.000
	1	1/4 = 0.250	0.333333	-1.099	0.333333	0.250
	2	2/4 = 0.500	1.000000	0.000	1.000000	0.500
	3	3/4 = 0.750	3.000000	1.099	3.000000	0.750
	4	4/4 = 0.999	999	6.907	999	0.999

Source: Author’s calculation

$$y_{ijk} = \beta_0 x_{0ijk} + \beta_1 x_{1ijk} + \beta_2 x_{2ijk} + \ldots + \beta_9 x_{9ijk} + (\rho_{0k} x_{0ijk} + \mu_{0j} x_{0ijk} + \varepsilon_{0i} x_{0ijk}) \quad (5.1)$$

where:

y	is the response variable, and included here as the expected probabilities to report all 3 activities of self-care activities or all 4 activities of mobility activities;
i	a subscript denoting level-1 units (individuals);
j	a subscript denoting level-2 units (PSUs);
k	a subscript denoting level-3 units (Provinces);
x_0	the constant and representing an individual with ‘base category’ characteristics (female, aged 60-69, with primary school education, did not work last week, owner of house, living with others ;
x_1- x_2	dummy predictor variables distinguishing different age categories (i.e. 70-79, and 80+);
x_3	dummy predictor variable distinguishing males;

$x_4 - x_5$ dummy predictor variables for different categories of educational level (i.e. secondary and beyond, and no education);
x_6 dummy predictor variables distinguishing those who worked in week previous to the survey;
x_7 - x_8 dummy predictor variables for house owner categories (children and others);
x_9 dummy predictor variable distinguishing those living without others;
β_0 the estimated fixed intercept term representing the global average score;
β_1 - β_9 estimated slope terms associated with level-1 predictor variables;
ε_0 level 1 random terms for individuals;
μ_0 level 2 random terms for PSUs;
ρ_0 level 3 random terms for provinces.

All the predictor variables are measured for individuals at level-1 and no higher level variables are available for level-2 units (PSUs) due to requirements to protect confidentiality. The three sets of random terms in Equation 1 can be summarised by three estimated variances: $\sigma^2_{\varepsilon 0}$, $\sigma^2_{\mu 0,}$ and $\sigma^2_{\rho 0}$; and together can be used to assess (and apportion) which levels provide the largest sources of variation in ability to perform self-care activities, thereby determining the relative importance of compositional and contextual variation in elderly health.

Equation (5.1) can be easily modified to allow individual-level predictor variables (e.g. age group or education) to vary randomly from place to place, both between different PSUs, and also different provinces. In the following example age is made to vary at all three levels:

$$y_{ijk} = \beta_0 x_{0ijk} + \beta_1 x_{1ijk} + \beta_2 x_{2ijk} + \ldots + \beta_9 x_{9ijk} + (\rho_{0k} x_{0ijk} + \rho_{1k} x_{1ijk} + \rho_{2k} x_{2ijk} + \mu_{0j} x_{0ijk} + \mu_{1j} x_{1ijk} + \mu_{2j} x_{2ijk} + \varepsilon_{0i} x_{0ijk} + \varepsilon_{1i} x_{1ijk} + \varepsilon_{2i} x_{2ijk}) \quad (5.2)$$

where the additional terms represent:

ε_0 now represents level-1 random terms for age 60-69;
ε_1 level-1 random terms for age 70-79;
ε_2 level-1 random terms for age 80+;
μ_0 now represents level-2 random terms for age 60-69;
μ_1 level-2 random terms for age 70-79;
μ_2 level-2 random terms for age 80+;

ρ_0 now represents level-3 random terms for age 60-69;
ρ_1 level-3 random terms for age 70-79;
ρ_2 level-3 random terms for age 80+.

There are now several sets of random terms in Equation 5.2 which can be summarised by nine estimated variances: $\sigma^2_{\varepsilon 0}$, $\sigma^2_{\varepsilon 1}$, $\sigma^2_{\varepsilon 2}$, $\sigma^2_{\mu 0}$, $\sigma^2_{\mu 1}$, $\sigma^2_{\mu 2}$, $\sigma^2_{\rho 0}$, $\sigma^2_{\rho 1}$ and $\sigma^2_{\rho 2}$; and six co-variances: $\sigma_{\mu 0\mu 1}$, $\sigma_{\mu 0\mu 2}$, $\sigma_{\mu 1\mu 2}$, $\sigma_{\rho 0,\rho 1}$, $\sigma_{\rho 0,\rho 2}$ and $\sigma_{\rho 1,\rho 2}$. The level-2 random terms provide differential differences in estimated level in self-care activities for populations aged 60-69, 70-79 and 80+ for the different PSUs. The co-variance terms allow assessment of whether areas with highest estimates for self-care activities for 60-69 are the same for 70-79 (or vice versa). Such a model formulation assumes a quadratic formulation for modelling level-2 between PSUs variation for aged 70-79 derived as: $\sigma^2_{\mu 0} + 2^* \sigma_{\mu 0\mu 1} + \sigma^2_{\mu 1}$, with the variation for aged 60-69 being determined by: $\sigma^2_{\mu 0}$ (Bullen et al. 1997). An alternative simpler linear formulation is possible: $\sigma^2_{\mu 0} + 2^* \sigma_{\mu 0\mu 1}$. This would be appropriate if the variance term for aged 70-79 differentials ($\sigma^2_{\mu 1}$) was found to be zero (Bullen et al. 1997) but the co-variance with aged 60-69 intercepts ($\sigma_{\mu 0\mu 1}$) has a non-zero estimate. Similarly, the level-3 random terms provide differential differences in estimated levels self-care activities for age group 60-69, 70-79 and 80+ for the different provinces. It is noted that there is no estimated level-1 co-variance term for gender at level one as by definition the characteristic is mutually exclusive (that is a person can only be male or female).

5.3.2 The Multilevel Models for Self-care Activities

Variance Components Model

A variance components model was fitted using the self-care activities data as dependent variable to explore the differences in ability to perform self-care. We start with the 'null' variance components models that just decompose the variation in response variable (Model 1 in Table 5.4), before including categorical predictor variables to explain variations in ability to perform self-care activities as shown in Equation 5.3.

Table 5.4: The estimates with standard error for variables predicting self-care activities using multilevel models

Model Self-care	**1 Variance Components Model Estimate (standard error)**	**2 Random Intercepts Model Estimate (standard error)**	**3 Random Slopes Model Estimate (standard error)**
Fixed Effects:			
Constant	6.291 (0.028)*	6.524 (0.045)*	6.560 (0.032)*
70-79	-	-0.195 (0.043)*	-0.236 (0.038)*
80+	-	-1.590 (0.063)*	-1.706 (0.100)*
Male	-	-0.072 (0.039)	-0.127 (0.030)*
Secondary & Beyond	-	0.078 (0.061)	0.093 (0.043)*
No Education	-	-0.242 (0.053)*	-0.142 (0.045)*
Worked Last Week	-	0.467 (0.043)*	0.404 (0.031)*
Children own house	-	-0.513 (0.058)*	-0.289 (0.050)*
Others own house	-	-0.310 (0.070)*	-0.191 (0.053)*
Live Alone	-	0.416 (0.068)*	0.202 (0.054)*
Random Effects:			
Level 3: Provinces			
Variance: Constant	0.026 (0.009)*	0.026 (0.009)*	0.012 (0.005)*
Level 2: PSU			
Variance: all	0.224 (0.036)*	0.259 (0.036)*	-
Variance: 60-69	-	-	0.278 (0.029)*
Variance: 70-79	-	-	0.159 (0.114)
Variance: 80+	-	-	1.368 (0.763)
Co-var: 60-69/70-79	-	-	-0.125 (0.045)*
Co-var: 60-69/80+	-	-	0.011 (0.111)
Co-var: 70-79/80+	-	-	0.325 (0.215)
Level 1: Individuals			
Variance: all	10.237 (0.089)*	9.710 (0.086)*	-
Variance: 60-69	-	-	3.701 (0.047)*
Variance: 70-79	-	-	6.564 (0.178)*
Variance: 80+	-	-	28.226 (1.021)*
Log-likelihood	156187	148223	138967

Source: Author's calculation
Note: * = Statistically significant at 5% level

$$y_{ijk} = \beta_0 x_{0ijk} + \rho_{0k} x_{0ijk} + \mu_{0j} x_{0ijk} + \varepsilon_{0i} x_{0ijk} \quad (5.3)$$

where:

y is the response variable, and included here as the expected probabilities to report all 3 activities of self-care activities;

i	a subscript denoting level-1 units (individuals);
j	a subscript denoting level-2 units (PSUs);
k	a subscript denoting level-3 units (Provinces);
x_0	the constant and representing an individual with 'base category' characteristics (female, aged 60-69, with primary school education, did not work last week, owner of house, living with others) ;
β_0	the estimated fixed intercept term representing the global average score;
ε_0	level 1 random terms for individuals;
μ_0	level 2 random terms for PSUs;
ρ_0	level 3 random terms for provinces.

When transformed the constant in Model 1 indicates that the probability of reporting high self-care activities for all people in all PSUs across all provinces is 0.998 which is equivalent to activities scores of 2.99/3. This implies that by average population in all places can perform almost all self-care activities. Based on Model 1, the total variance was 10.487 which contained the between provinces and PSUs variance as estimated at 0.026 and 0.224 respectively.

The individual level provides the largest variance at 10.237 or 97.6 percent of the total variance; whilst provinces and PSUs only account for 0.2 percent and 2.1 percent respectively. There is little contextual variation in self-care activities between provinces and primary sampling units; the majority of variation is associated with individuals. However, Wald tests for the random terms indicated that they were all statistically significant at 95% probability level. These tests involve comparing whether the variances of PSUs and provinces are significantly different from zero using a chi-square distribution (see Chapter 4, Section 4.3; and also Jones 1991, Harrell 2001). This confirms that the different levels of geographical areas need to be taken into account. In Model 1 there are two provinces that have statistically significant different likelihoods of reporting self-care activities. Maha Sarakham is a province where the probability of reporting all 3 activities of self-care was lower than average, whereas Kalasin has higher than average level of self-care activities. At PSU level, there are some PSUs which have statistically significant likelihoods of lower and higher level of self-care activities. However, due to the data protection of the Survey of Elderly in Thailand in 2007 the PSUs cannot be identified here.

Random Intercept Model

Model 2 (Table 5.4) is the random intercept model that takes into account individual characteristics of age, gender, education, working status, housing tenure and living arrangement by including these in the model as main effects. The estimate for the constant of Model 2 is 6.524 on the log odds scale, and when transformed implies the probability of reporting that they can perform all 3 self-care activities is 0.999 for a stereotypical respondent with base category characteristics (female aged 60-69, educated to primary school level, who has not worked last week, lives in own house with other).

The predictor variables included in Model 2 are statistically significant except for male and being educated to secondary level or beyond. The estimates in the main effects indicate that the probabilities of reporting all 3 self-care activities are reduced when people get older and the probability for women is higher than that for men controlling for other variables. The elderly population who have lower levels of education also tend to report lower probability of being to perform all 3 activities of self-care than those with higher education levels. Elderly who did not work in the week previous to the survey, who did not own their houses and who lived with others have lower probability to report all 3 activities of self-care compared to elderly who worked in the week prior to the survey, who owned their houses and lived alone. Figures 5.1 summarises the overall variations in predicted probability of being able to perform all 3 self-care activities (logit transformation) graphically for different predictor categories of the main fixed effects included in Models 2. The figure is based on the four point scale data (0-3 activities), and shows the overall probability of reported all 3 self-care activities for all individuals in all PSU and all provinces.

Interestingly, inclusion of level 1 individual characteristics in Model 2 have increased the level 2 variations, while the level 3 variations stay the same when compared with Model 1. Jones (1992) has reported that it is possible to increase the level 2 variance once individual variables/predictors are included in the model. This might be due to some individual characteristics that provide high impacts on the differences between places of the response variable. For example, including house size in the modelling of difference house prices between areas will increase the variation at level 2 or area level (Jones 1992). Before adding house size, prices are more similar across areas with the expensive areas tend to have small house, then including house size will increase the variation in house prices between areas.

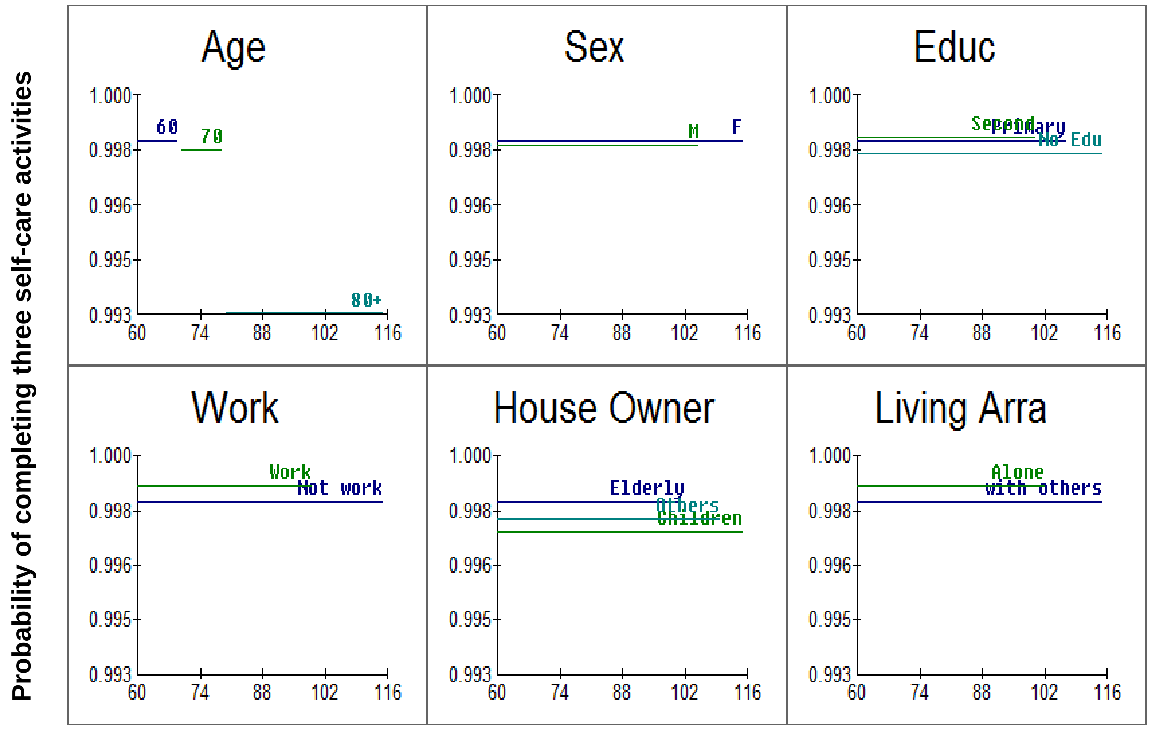


Figure 5.1: The differences between categories of predictors of the probability of being able to perform all three self-care activities
Note: The x-axis relates to respondent's age (measured on a continuous scale) is only used here to facilitate graphing for six explanatory variables shown and included in Model 2. Age was actually modelled as three categories in first panel.

Here in terms of reported of being able to perform all three self-care activities, there are some provinces that have lower predicted rates of being able to perform all three self-care activities than expected given their social and demographic characteristics. Similarly, there are some provinces that have higher predicted rates of being able to perform all three self-care activities than expected given their higher social status and younger characteristics of their respondents. In other words a compositional explanation (i.e. characteristics of people who live in provinces and PSUs) does not provide a full explanation for geographical variations in performance of self-care activities. Two possible explanations can be put forwards here. Either there are other important individual (compositional) variables not modelled here (nor measured in the Survey of Elderly in Thailand) or contextual place and/or collective place characteristics help provide explanations for geographical variations.

In Model 2, the levels of education might lead to different probabilities of reporting all 3 activities of self-care between PSUs because the elderly who graduated primary school and live in PSUs in rural areas tend to have more income than those who live in PSUs in urban areas. The different incomes might lead to different health statuses. Moreover, some PSUs have a small number of respondents then the inclusion of individual characteristics will lead to the increase of differences in self-care activities between PSUs.

All random terms in Model 2 are statistically significant at 5% level. However, based on total variance of 9.995, the level 1 variation is the largest at 97.15 percent whereas PSUs and provinces provide 2.59 percent and 0.26 percent respectively. Figure 5.2 shows the residuals of the random terms for each of the 76 provinces (level 3) derived from Models 2.

The ‘caterpillar plot’ shows the residuals (represented by the triangles) together with their 95% confidence interval and ordered from lowest to highest (Rasbash et al. 2004). Those residuals with confidence limits that break the zero line are not statistically different from zero (and the overall constant for all people in all provinces), and almost all of the provinces have overlapping confidence intervals suggesting that these provinces are not statistically different from each other. There is only one province with statistically significant lower levels of self-care activities than the overall average. This province is Maha Sarakham which is the same as found in Model 1.

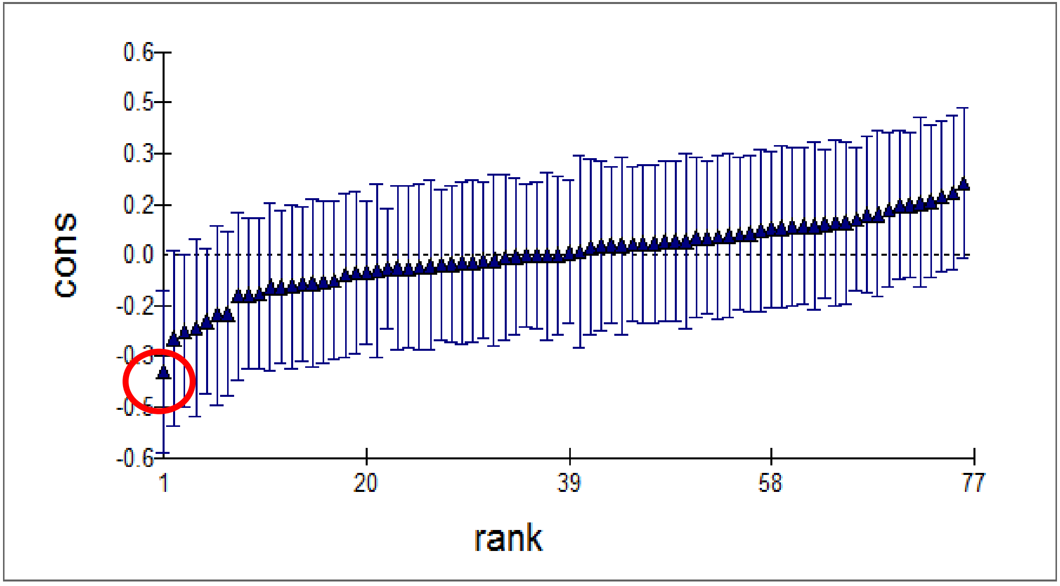


Figure 5.2: Residual with its 95% confidence band against rank from Model 2
Notes: cons = the average probabilities of all provinces in reporting 3 activities of self-care
rank = rank of residual of each provinces that differ from the constant

Random Slope Model

In Model 3, Table 5.4, the age groups were allowed to vary at level 2 (PSUs) and level 1 (individuals) to investigate the relationship between age and level of self-care activities across all PSUs. The results in Table 5.4 show that the estimate for the constant is 6.560 which implies that the probability of reported that they can perform all 3 self-care activities is 0.999 for an individual with base category characteristics (females aged 60-69 graduated primary education, who own a house, live with someone and did not work in the week prior to the survey). The average level of self-care activities obtained from Models 1, 2 and 3 are not different. All the predictors in the fixed effects in Model 3 were statistically significant.

The level 1 variance for individuals aged 80+ is larger than the variance for aged 60-69 and 70-79 (Model 3 in Table 5.4). The variation for those aged 60-69 is 3.701, for those 70-79 is 6.564 and 28.226 for 80+. All the estimates used to derive measures of level 1 variation (i.e. variances and co-variance terms) were found to be statistically significant when tested with Wald tests. These results show the value of decomposing level-1 variation, and demonstrate the heterogeneous nature of the data. This is not surprising, as one expect both the ‘oldest old’ to report less ability to undertake self-care activities (i.e. have more disability) and also for these respondents to be more variable in health experience (Freedman et al. 2002).

The level 2 variation between PSUs is 0.278 for those aged 60-69 (base category); and 0.188 for those aged 70-79 (0.278+[2*(-0.125]+0.159); and 1.669 for those aged 80+ (0.278+[2*0.011]+1.368). The correlation of the co-variance between age group 60-69/70-79, 60-69/80+ and 70-79/80+ are -0.594, 0.018 and 0.696 respectively. The results show that there are place-specific age differentials in ability to perform self-care activities for individuals in different PSUs. However, Wald-tests for random terms at PSUs level were not statistically significant except for age 70-79. This result shows that there is not a different spatial pattern in predicted levels of self-care activities by age. The results on the variation between provinces on the relationship of level of self-care activities and age show there are not statistically significant differences between provinces in level 3. The Model is not presented here.

5.3.3 The Multilevel Models for Mobility Activities

Variance Components Model

A variance components model was fitted using the mobility activities data to explore the differences in level of ability to perform these activities in old age Thai. The ‘null’ variance components model was started to decompose the variation in response variable (Model 4 in Table 5.5). Model 4 is then useful in benchmarking the amount of variation between level 2 primary sampling units (PSUs) and between level 3 provinces before including predictor variables. The respondent variable on levels of mobility activities was transformed into probabilities of reporting the ability to carry out all mobility activities in Model 4 because MLwiN cannot fit ordinal regression models (Rasbash et al. 2004). These continuous mobility activities are modelled using a ‘normal theory’ linear multilevel model (Johnston et al. 1995). The constant provides an estimate of the average level.

Table 5.5: The estimates with standard error for variables predicting mobility activities using multilevel models

Model Mobility	**4 Variance Components Model Estimate (standard error)**	**5 Random Intercepts Model Estimate (standard error)**	**6 Random Slopes Model Estimate (standard error)**
Fixed Effects:			
Constant	3.223 (0.075)*	3.655 (0.088)*	3.820 (0.073)*
70-90	-	-1.971 (0.071)*	-2.055 (0.074)*
80+	-	-5.799 (0.104)*	-5.990 (0.139)*
Male	-	0.931 (0.064)*	0.721 (0.057)*
Secondary & Beyond	-	0.630 (0.101)*	0.641 (0.086)*
No Education	-	-0.806 (0.089)*	-0.681 (0.086)*
Worked Last Week	-	2.328 (0.071)*	2.135 (0.061)*
Children	-	-1.172 (0.095)*	-0.945 (0.094)*
Others	-	-0.546 (0.115)*	-0.506 (0.103)*
Live Alone		0.549 (0.110)*	0.373 (0.103)*
Random Effects:			
Level 3: Provinces			
Variance: Constant	0.274 (0.068)*	0.207 (0.055)*	0.133 (0.038)*
Level 2: PSU			
Variance: all	2.640 (0.165)*	2.690 (0.146)*	-
Variance: 60-90	-	-	1.552 (0.128)*
Variance: 70-79	-	-	2.227 (0.428)*
Variance: 80+	-	-	8.855 (1.404)*
Co-var: 60-69/70-79	-	-	0.654 (0.176)*
Co-var: 60-69/80+	-	-	0.193 (0.321)
Co-var: 70-79/80+	-	-	2.832 (0.578)*
Level 1: Individuals			
Variance: all	33.042 (0.287)*	25.097 (0.224)*	-
Variance: 60-69	-	-	15.089 (0.193)*
Variance: 70-79	-	-	15.238 (0.553)*
Variance: 80+	-	-	28.855 (1.488)*
Log-likelihood	193562	177928	174796

Source: Author’s calculation
Note: * = Statistically significant at 5% level.

In Model 4, the transformed constant indicated that the probability of reporting all 4 mobility activities for all people in all PSUs across all provinces is 0.962. This implies that by average population in all places can perform 3.84 activities from total 4 activities. Based on Model 4 in Table 5.5, the estimation of variance between provinces and PSUs are 0.274 and 2.640 respectively. However, the largest variance is found at level 1 at 33.042 or 91.9 percent of the total variance, whilst provinces and PSUs only account for 0.8 percent and 7.4 percent respectively. There is little contextual variation in self-care activities between provinces and primary sampling units; the majority of variation is associated with individuals. When compared, the variations in mobility activities with the variations in self-care activities, the results show that the variations level of mobility activities between provinces and PSUs were larger than the variations of self-care activities. The Wald tests of random terms in Model 4 show that they were all statistically significant at 5% level.

This confirms that there were differences between geographical areas in reporting levels of mobility activities. At the province level of Model 4 there are eight provinces that have statistically significant different likelihoods of average level mobility activities. At PSUs level, there were some PSUs which have statistically significant likelihoods of different level of mobility activities.

Random Intercept Model

Model 5 (Table 5.5) is a random intercept model that takes into account individual characteristics of age, gender, education, working status, housing tenure and living arrangement by including these in the model as main effects. The estimation of the constant of Model 5 is 3.655 on the log odds scale which, when transformed, implies the probability of reporting total 3 activities of mobility was 0.975 or 3.9/4 activities for a stereotypical respondent with base category characteristics (female aged 60-69, educated to primary school level, who has not worked last week, lives in her own house with others).

The predictor variables included in Model 5 are all statistically significant. The estimates in the main effects show that the probabilities of reporting total mobility activities are reduced when people get older and the probability of women are lower than men controlling for others variables. The probability of Elderly aged 70-79 and 80+ to report total 4 activities of mobility activities were estimated as 0.843 and 0.105 respectively. Whereas the probability for men were 0.989 that estimated to report performed all activities of mobility. The relationship between level of education and level of mobility activities based on Model 5 showed that the probability of elderly who graduated secondary school or beyond was 0.986 and the probability of elderly with no education was 0.945 to report performed all activities of mobility. The elderly who worked in the previous week of surveying had a higher probability to report ability to perform all activities of mobility than who did not. The estimate of the fixed effect in Model 5 also shows that the elderly who live alone had a higher probability than those who live with others in reporting all activities of mobility. The relationship between housing tenure and level of mobility was found that elderly who live in houses owned by their children or others had a lower level of mobility than elderly who live in their house. This is probably due to a selection effect. The mobile elderly are able to maintain an independent household. The immobile elderly need the care of their families or others.

Figure 5.3 summarises the overall variations in predicted probability of level of mobility (logit transformation) graphically for different predictor categories of the main fixed effects included in Model 5. The figure is based on the five point scale data, and show the overall probability of reported total (high) mobility activities for all individuals in all PSU and all provinces.

Inclusion of level 1 individual characteristics in Model 5 have interestingly increased the level 2 variations while the level 3 variations stay the same when compared with Model 4. This result can be explained as found in modelling the ability to perform self-care activities in Section 5.4.3 random intercept model (Model 2, Table 5.4). All random terms in Model 5 are statistically significant at 5% level. However, the level 1 variation is the largest at 89.65 percent whereas PSUs and provinces provide the variation 9.61 percent and 0.74 percent respectively.

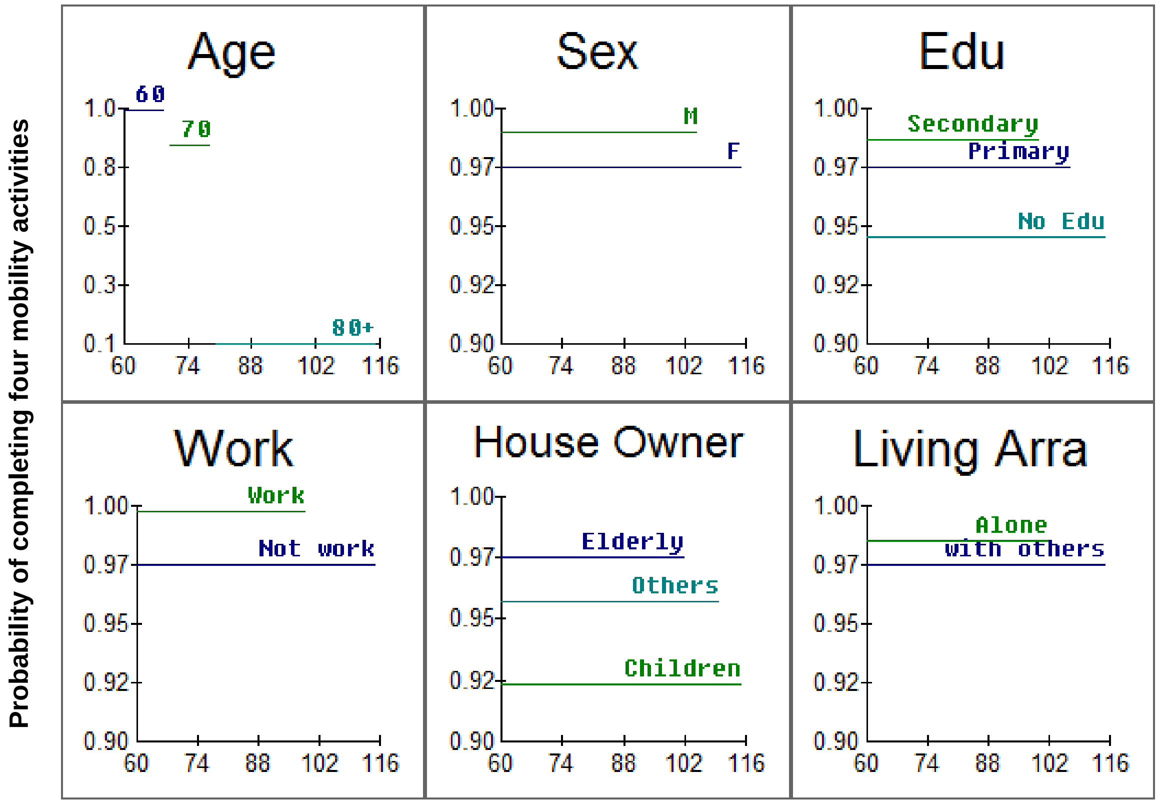


Figure 5.3: The differences between categories of predictors on mobility activities
Note: The x-axis relates to respondents age (measured on continuous scale) and is only used here to facilitate graphing for six explanatory variables shown and included in Model 5. Age was actually modelled as three categories in first panel.

Figures 5.4 shows the residuals of random terms for each of the 76 provinces (level 3) derived from Models 5. The ‘caterpillar plot’ shows most of the provinces have overlapping confidence intervals suggesting that these provinces are not statistically different from each other. There are eight provinces with statistically significant different levels from the average level of mobility activities. Prae and Pijit were provinces with lower level of mobility activities whereas Supanburi, Nakhon Nayok, Loei, Trat, Mae Hongsorn and Chumporn had higher than average level of mobility activities. These results suggest that there might be some difficulties in the living environment (such as the low quality of public transport for elderly to perform their daily activities in Prae and Pijit that lead to the low probabilities of reporting all activities of mobility. Moreover, the variation in health care services and health behaviour between provinces might be a cause of variations in activities of mobility in elderly Thai.

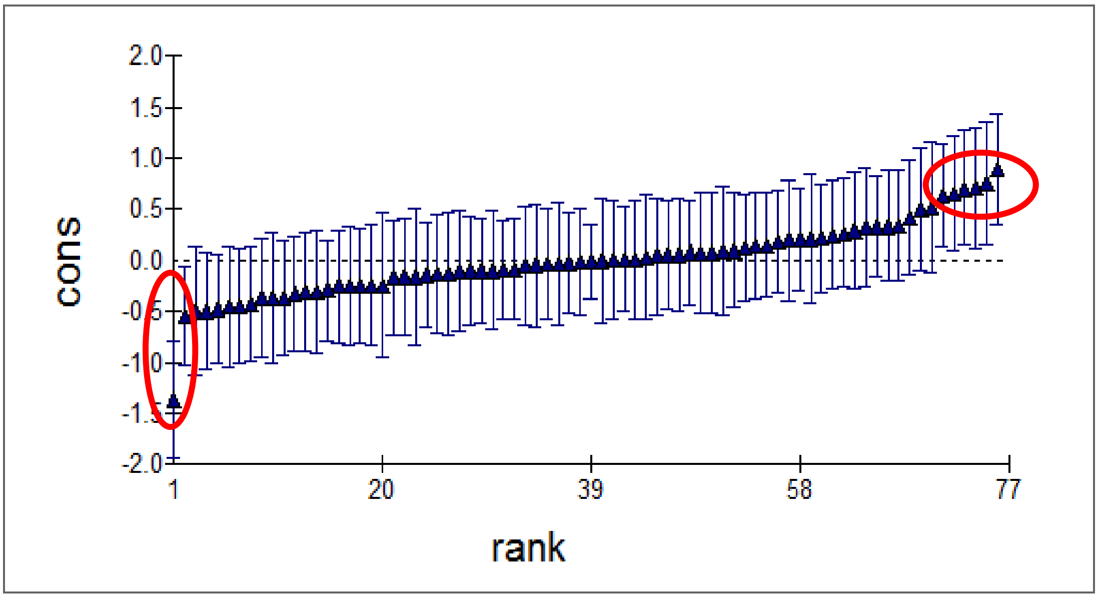


Figure 5.4: Residual with its 95% confidence band against rank from Model 5
Notes: cons = the average probabilities of all provinces in reporting 4 activities of mobility
rank = rank of residual of each provinces that differ from the constant

Random Slope Model

In Model 6, Table 5.5, the age groups were allowed to vary at level 2 (PSUs) and level 1 (individuals) to investigate the relationship between age and level of mobility across all PSUs as applied for self-care activities in Section 5.3.2. The results in Table 5.5 show that the estimate for the constant is 3.820. This implies the probability of reported total mobility activities is 0.979 for an individual with base category characteristics (females aged 60-69 who graduated primary school, own their house, live with someone and did not work in the week prior to the survey). The Wald-tests show that all the predictors in the fixed effects in Model 6 were statistically significant.

The level 1 variance for individuals aged 80+ was larger than the variance for aged 60-69 and 70-79 (Model 6 in Table 5.5). The variation for those aged 60-69 is 15.089, for those 70-79 is 15.238 and 28.855 for 80+. All the estimates used derive measures of level 1 variations were found statistically significant when tested with Wald-tests. These results show the value of decomposing level 1 variation, and demonstrate the heterogeneous nature of the data. These are the same as found in self-care activities, as one expect both the ‘older’ to report less ability to undertake mobility (i.e. have more disability) and also for these respondents to be more variation in health status.

The level 2 variation between PSUs is 1.552 for those aged 60-69 (base category); and 5.088 for those aged 70-79 (1.552+[2*0.654]+2.227); and 10.794 for those aged 80+ (1.552+[2*0.193]+8.855). The correlation of the co-variance between age group 60-69/70-79, 60-69/80+ and 70-79/80+ are 0.352, 0.052 and 0.638 respectively. The results show that there are place-specific age differentials in ability to perform mobility activities for individuals in different PSUs. Wald-tests for random terms at PSUs level almost all were statistically significant except for the co-variance 60-69/80+. This result shows that there is a different spatial pattern in predicted levels of mobility activities by age. The results on the variation between provinces on the relationship of level of mobility and age show there are not statistically significant differences between provinces in level 3. The Model then is not presented here.

5.4 Discussion and Conclusions

The Surveys of Elderly in Thailand in 2002 and 2007 show an increase in the number and proportion of oldest old (those aged 80+) and elderly women between this period. Moreover, the elderly population has low level of education and tend to have low economic level. These demographic and socioeconomic characteristics changed between 2002 and 2007, related to the differences in health status of old age. The estimates of the effect of demographic and socioeconomic characteristics including age groups, gender, education, working status, housing tenure and living arrangement in the fixed effects part of multilevel modelling were statistically revealing significant differences in health status within the old age Thai population. The results show the increase of self-care and mobility limitation with age and that elderly women were more likely to report poor health than men. These will affect the demand for health services and increase in health expenditure in Thailand in the future if the number and proportion of elderly Thai continue to increase as occurred in 2002-2007. Society will need to find ways of supporting both increasing numbers of frail older persons and the family members who care for them. Moreover, the lower education and economic levels are associated with the lower levels of self-care and mobility. This will add more impacts of the rising of oldest old on health problems as the period effect due to this group of population completed low education or no education and were labour inactive. While the cohort effect is that in the future the oldest old will have improving educational levels as the less educated cohorts die out and are replaced by more educated cohorts.

The study of Thai variations in elderly health based on 2007 self-care activities and mobility activities shows that there are variations between provinces and local residence areas (PSUs) as the random terms in multilevel modelling are all statistically significant (Models 1, 2, 4 and 5). The results from Model 2 in Section 5.3.2 show that Maha Sarakham has statistically and significantly lower levels of predicted *self-care activities* compared to the overall average (a probability of 0.998) and also other provinces. This difference in level of performing three self-care activities might relate to the differences in the demographic (compositional) and geographical (contextual) characteristics of this province compared to the others. Maha Sarakham is located in the Northeast of Thailand, which is the poorest region of the country (NSO 2007a). The low level of income and development in rural residential areas might affect the health status of the residences and accessibility to health care services. In 2007 almost 90 percent of elderly in Maha Sarakham lived in rural areas (NSO 2008).

The variation in elderly health based on *mobility activities* in Model 5, Section 5.3.3 show that Prae and Pijit were the provinces which the elderly had statistically significant lower level of mobility than the overall average. The lower level of elderly mobility in these provinces might due to the lack of public transport and social services in these two provinces. Most of the elderly in these two provinces live in rural areas (74.9 percent in Prae and 80.9 percent in Pijit) (NSO 2008). Prae and Pijit are located in the North region of Thailand where the levels of poverty are higher than in the other regions (except for the Northeast). Poverty might limit the resources (e.g. good quality food, medicines) available to maintain the health status of the population. The low level of development in these provinces might also affect the availability of health care and social services.

The variations in health status between provinces were small when compared with the variations between PSUs. This trend of health variations between province and PSUs in 2007 were the same as in 2002 for Thailand. However due to the limitation of the data on details of PSUs this study cannot identify the differences in PSUs. Moreover, the results from the random slope model (Model 3 and Model 4) show that the relationship between age and level of mobility varied between PSUs but was neither large or nor statistically significant between provinces. The details of the PSUs level or the lower level of geographical areas than province will be useful to investigate the health variations in old age between places in Thailand. To achieve this, the details of PSUs might be released in term of PSUs characteristics such as identified by social class of these local areas without the identifiable information will be more useful for investigating the impacts of PSUs on variations in health in old age.

In the next chapter, the variations of health in elderly Thai between 2002 and 2007 will be investigated using the healthy life expectancy. The results will present the proportion of healthy life years within their total expected years of living and also explore the differences in healthy life expectancies between gender and age.

CHAPTER 6
HEALTHY LIFE EXPECTANCY IN THAILAND

6.1 Introduction

This chapter aims to investigate trends in the healthy life expectancies of Thai people in old age between 2002 and 2007 based on self-rated health and disability measured using activities in daily living (ADLs). The Sullivan method for computing healthy life expectancy is applied because prevalence data on health are available but not transition data. The results also provide the ability to investigate the extent to which increasing life expectancy in old age in Thailand is accompanied by an increase in good or poor health. To achieve the aim, trends in healthy life expectancy both in developed and developing countries are explored in Section 6.2. In particular, the differences in health trends due to different health indicators will be examined. The steps for calculating a period life table for Thailand are presented in Section 6.3 and then the results from this calculation are discussed in Section 6.4. Health prevalence based on self-rated health, self-care disability and mobility disability are explored in Section 6.5. The calculation of healthy life expectancy based on the Sullivan method is introduced for calculating healthy life expectancy in Thailand in Section 6.6 and results are presented in Section 6.7. Finally the results are discussed in various ways and then the conclusions are made in Section 6.8.

6.2 Trends in Healthy Life Expectancy

Healthy life expectancy is the measurement of health that takes into accounts both mortality and morbidity, because living longer does not necessarily mean living in a healthy life state. Healthy life expectancy then provides the ability to evaluate quality of life with respect to health by estimating the average life time spent in different health states (Brønnum-Hansen 2005). The concept of healthy life expectancy is based on the combination of life expectancy (measured using mortality statistics) and health prevalence rate (measured using morbidity or disability statistics). Health is a multidimensional phenomenon which can be measured by a variety of indicators as discussed in Chapter 2. Different health indicators show varying levels and trends in health. Trends in health expectancy depend on the health indicators used. Healthy life expectancy in old age is usually calculated based on one of the following concepts: self-rated general health, self-rated disability, disability on activities in daily living (ADLs), instrumental activities in daily living (IADLs) and chronic diseases.

The healthy life expectancy in old age based on the self-rated health has been investigated both in the developed and developing countries. However, the trends in healthy life expectancy showed inconsistent patterns, varying by country and time period. Reports on health trends in elderly people in both developed and developing countries show an inconsistent pattern. For example, the study of health trends among the elderly aged 65 and over in United States showed a significant improvement in self-rated health between 1993 and 2001 (Zack et al. 2004), whereas a study in United Kingdom found worsening self-rated health during the 1980s (Spiers et al. 1996). An Austrian study showed that between 1978 and 1998, improvements in self-reported health were reported for the population aged 60 to 84 but not for older groups (Doblhammer and Kytir 2001).

In England and Wales, Bebbington (1988) found that from 1976 to 1985 disability free life expectancy increased more slowly than life expectancy for men. The proportion of years spent without disability within total life expectancy fell from 83.1 percent in 1976 to 81.8 percent in 1985. Disability free life expectancy for women ceased to increase when life expectancy increased so that the proportion of years spent without disability fell from 81 percent to 79 percent. Thus the results from this study confirmed the expansion of morbidity hypothesis (Bebbington 1988). Furthermore the study of healthy life expectancy using incidence based estimates for the United Kingdom also showed that the healthy life expectancy rose between 1992 and 2002 but the gain was smaller than the increase in total life expectancy, confirming the expansion hypothesis (Ehsan et al. 2008).

A study of health expectancy in Denmark between 1987 and 2000 using Sullivan's method showed that the life expectancy of 65 year old men and women had increased and the expected lifetime in self-rated good health and disability free life expectancy had also improved both for men and women, but life expectancy without longstanding illness had decreased (Brønnum-Hansen 2005). The rise in life expectancy in Denmark appears to be accompanied by improved health status among the elderly. Studies in healthy life expectancy have also confirmed that men spend a smaller proportion of their life in poor health than women do although the absolute healthy life expectancy remains higher in women. Therefore, women may live longer, but a greater proportion of their life in bad health (Wilkins and Adams 1983; Robine and Ritchie 1991).

A study of disability free life expectancy in Xichang prefecture in Sihuan province, China using the ADLs including bathing, dressing, going to toilet, transferring, continence, feeding, and grooming and instrumental activities of daily living (IADLs) including food preparation, housekeeping, shopping, and handling money found that at age 65, 84.4 percent of life expectancy was spent free from ADLs and IADLs disability. The results also showed that females lived longer than males but their total of healthy life years were lower than males (Qiao et al. 1993).

A study of healthy life expectancy in eight Asian countries including Malaysia, Philippines, South Korea, Burma, Indonesia, North Korea, Sri Lanka and Thailand used ADLs to represent health status. The measurements cover the ability to eat, dress and undress oneself, take care of one's appearance, walk, get in and out of bed or the place where one sleeps, and take a bath or shower. Inability to perform at least one of these six activities was classified as disabled. The results show that the percentage of remaining life time free from disability decreased by age and the proportion of active life expectancy to total life expectancy is higher for males than females in all age groups particularly in older age groups rather than younger age groups and in all countries (Saito et al. 2003).

A report on disability free life expectancy in Thailand was presented by Jitapunkul et al. (2003). The study used the activities in daily living and long-term disability to measure the health of elderly Thai aged 60 and over. The prevalence rate was obtained from the National Health Examination Survey II conducted in 1997. The activities in daily living included feeding, grooming, transferring, toileting, dressing and bathing. The inability to perform one or more of these six activities was defined as self-care disability, while long-term disability was defined as the limitation in activities from any condition or health problem for 6 months or longer. The disability prevalence rate in old age increased by age in all health domains. The disability rate was higher for females than males at all ages and the proportion of disability free life expectancy and long-term disability to life expectancy was lower for females than males. The proportion of self-care disability free life expectancy versus life expectancy was 92 percent for males and 89 percent for females at age 60 and was 82 percent and 79 percent respectively at age 80+ (Jitapunkul et al. 2003, Jitapunkul et al. 2001, Jitapunkul et al. 2002). Jitapunkul and Chayovan (2000) reported the healthy life expectancy based on the self-reported health between 1986 and 1995. The result showed an increase in life expectancy and healthy life expectancy in all age groups and both sexes. The proportion of the healthy life expectancy versus life expectancy for males was higher than females in all age groups. This was the same results as for disability free life expectancy in 1997.

We have already pointed to the difficulty of comparing results between studies because of the different ways that ill health and disability are measured. Van Oyen et al. (2008) report on a study of health expectancy in the older population of Belgium using four different measures for the same population. These measures covered the health domains of self-reported health, one chronic disease, two or more chronic diseases experienced jointly and disability. They compare the distribution of life expectancy by different health states for persons at age 65 and at age 80. Their results were as follows: for men aged 65 the compression hypothesis held for the two illnesses and the disability measures but not for self-reported health where the equilibrium hypothesis was a better description. For women at ages 65 and 80 and for men at age 80 none of the changes in health expectancy were significant but the expansion hypothesis described the changes best. So we should expect differences to manifest themselves between the measures used, between the sexes and between younger and older ages in the old age range. It is not surprising therefore that reviews of changes in health expectancy change across a number of developed countries present a varied picture by country and time period of study (Robine et al. 1999, Mathers and Robine 1997, Christensen et al. 2009).

6.3 Life Expectancy: Method for Constructing a Period Life Table

To calculate healthy life expectancy using the Sullivan method needs the combination of life spent in different age bands derived from period life tables, with the age and sex specific health prevalence rates. Then the ingredients needed for calculating healthy life expectancy for elderly Thai are divided into two components: period life tables and health prevalence rates by age and sex for Thailand.

The life table method provided by Rowland (2003) and Rees (2008) is applied and the top age group is set at 100+ in order to compare with WHO life tables. However life tables look complicated for people unfamiliar with them. Here we provide an account of the variables and the functions that connect them.

6.3.1 Estimated Mortality Rates for Thailand for Ages 70 and Over

The deaths data published by Thailand vital registration in 2002 and 2007 have a final age category of 70 and over. To construct a life table for Thailand, the number of deaths of ages 70-74, 75-79, ... , 100+ are required.

The mortality rates above age 70 for Thailand population in 2007, ${}_nM_x$ (2007), are estimated using the age-specific mortality rates in the 2006 WHO Life Table for Thailand, ${}_nM_x^{WHO}$ (2006), the mid-year population estimates by age for Thailand in 2007, ${}_nP_x$ (2007), and the deaths at ages 70 and over, D_{70+} (2007):

$${}_nM_x(2007) = {}_nM_x^{WHO}(2006) \times \frac{D_{70+}(2007)}{\sum_{x=70}^{x=100} {}_nM_x^{WHO}(2006)\, {}_nP_x(2007)} \qquad (6.1)$$

This equation is used for males and females. The calculations for males are illustrated in Table 6.1.

Table 6.1: The estimation of mortality rates for Thailand for males age 70 and over in 2007

Age group	**Mortality Rate WHO (2006)**	**Population (2007)**	**Initial Estimates of Deaths (2007)**	**Adjusted Estimates of Mortality Rate(2007)**
x	${}_nM_x^{WHO}$ **(2006)**	${}_nP_x$**(2007)**	${}_nD'_x$**(2007)**	${}_nM_x$**(2007)**
(1)	**(2)**	**(3)**	**(4)**	**(5)**
70-74	0.03861	597,005	23,050	0.03604
75-79	0.05714	379,143	21,664	0.05333
⋮	⋮	⋮	⋮	⋮
100+	0.45699	11,877	5,428	0.42655
Total			85,945	D_{70+}(2007)=80,220

Source: Author's calculation
Note: the estimated mortality rates in column (5) are obtained by multiplying the column (2) rates by the ratio of the column (5) total, observed deaths for ages 70 and over, to the sum of the initial estimates of deaths by age column (4) total.

6.3.2 Central Death Rates or Age Specific Mortality Rates (${}_nM_x$)

Since we have mid-year population (${}_nP_x$) and the number of deaths (${}_nD_x$) in one calendar year, then the central death rates or age-specific death rates are calculated as the number of deaths divided by the mid-year population.

$$ {}_nM_x = \frac{{}_nD_x}{{}_nP_x} \quad (6.2) $$

where

n= the number of years in the age interval,

${}_nP_x$ = mid-year population age x to x+n,

and

${}_nD_x$ = number of deaths during the year to persons aged x to x+n

6.3.3 Probability of Dying in Each Age Interval ($_nq_x$)

This is computed as followed (Rowland 2003):

$$_nq_x = (2n * {_nM_x})/[2 + (n \times {_nM_x})] \quad (6.3).$$

It is sometimes given as (Rees 2008):

$$_nq_x = \frac{n * {_nM_x}}{[1+(0.5 * {_nM_x})]} \quad (6.4).$$

6.3.4 Probability of Surviving from One Exact Age to the Next ($_np_x$)

This is computed thus

$$_np_x = 1 - {_nq_x} \quad (6.5).$$

6.3.5 Number Surviving at Exact Ages (l_x)

This is computed as:

$$l_{x+n} = l_x \times {_np_x} \quad (6.6).$$

For the first age, this equation is

$$l_1 = l_0 \times {_1p_0} \quad (6.7)$$

where

l_0 is the radix of the life table and is set to 100,000, equivalent to hypothetical number of births in a year to the stationary population of the life table.

6.3.6 Number of Deaths between Exact Ages ($_{n}d_{x}$)

This is generally:

$$_{n}d_{x} = l_x \times {}_{n}q_{x} \qquad (6.8).$$

6.3.7 Person Years Lived in Age Interval between Age x to x+n ($_{n}L_{x}$)

The general equation for persons years live in an interval is:

$$_{n}L_{x} = \frac{n}{2}(l_x + l_{x+n}) \qquad (6.9)$$

The general equation is modified for age 0, age 1 and age 100+:

$$L_0 = 0.3l_0 + 0.7l_1 \qquad (6.10)$$

$$_{4}L_1 = \frac{4}{2}(l_1 + l_5) \qquad (6.11)$$

$$L_{100+} = \frac{l_{100+}}{M_{100+}} \qquad (6.12)$$

6.3.8 Total Population Years Lived beyond Aged x (T_x)

T_x is the sum of the $_{n}L_{x}$ values from age x

$$T_x = \sum_{x}^{100} {}_{n}L_{x} \qquad (6.13)$$

6.3.9 Expectation of Life (e_x)

Life expectancy is computed thus:

$$e_x = T_x / l_x \qquad (6.14)$$

6.4 Life Tables for Thailand

The period life tables for Thailand 2002 and 2007 are calculated based on mid-year population and number of deaths by age and sex. These data obtained from vital registration. The number of deaths in 2002 and 2007 from vital registration are available in five year age groups for ages 0, 1-4, 5-9, ... , 65-69 whereas the number of deaths for age group 70 and over are combined. The number of deaths for age group 70-74, 75-79, ... , and 100+ are estimated based on Central Death Rate ($_nM_x$) of WHO life tables for Thailand 2002 and 2006 respectively. An example of this calculation was presented in Section 6.3. The period life table method (as explained in Rowland 2003, Chapter 8) is applied for calculating the Thailand life table for 2002 and 2007. Thailand period life tables for males and females in 2002 and 2007 are presented in Tables 6.2 and 6.3 respectively.

These calculations show that life expectancy at birth both for males and females has increased. Life expectancy at birth for males increased by 2.2 years in the 5 years period whereas life expectancy at birth for females increased by 2.7 years within the same period (Table 6.4). Thai females have greater life expectancy at birth than males in both 2002 and 2007. The gender difference in life expectancy at birth in 2002 was 6.0 years while in 2007 was 6.6. These imply that females tend to live longer than males in Thailand. However, the life expectancy at birth for males and females obtained from WHO life tables for Thailand 2002 and 2006 are 66.0 (male-2002) and 72.7 (female-2002) and 69.0 (male-2006) and 74.9 (female-2006) (WHO 2007b). The life expectancies at birth from the WHO life tables for Thailand are lower than the life expectancies obtained from Thailand vital registration data by around 3 years both for male and female in 2002.

The WHO life table for Thailand in 2007 is not available but the comparison between 2002 and 2006 also shows the increase of life expectancy at birth for both males and females. Life expectancy at birth for males increased 3 years from 2002 to 2006 and females life expectancy at birth increased 2.2 years in the same period. The gender differences in life expectancy at birth between 2002 and 2006 show that females tend to live longer than males.

Table 6.2: Period life table for Thailand 2002

Age at start of interval	Mid-year population	Number of Deaths	Central Death rate	Probability of Dying between age x to x+n	Probability of Surviving between age x to x+n	Number of Surviving to age x	Number of Deaths between age x to x+n	Person Years lived in age interval between age x to x+n	Total Numbers of years lived from age x	Total Life Expectancy
x	$_nP_x$	$_nD_x$	$_nM_x$	$_nq_x$	$_np_x$	l_x	$_nd_x$	$_nL_x$	T_x	e_x
MALES										
0	394,564	2,845	0.00721	0.00719	0.99281	100,000	719	99,497	6,940,040	69.4
1	1,821,764	2,217	0.00122	0.00486	0.99514	99,281	482	396,162	6,840,543	68.9
5	2,583,402	1,939	0.00075	0.00375	0.99625	98,799	370	493,072	6,444,381	65.2
10	2,494,040	1,575	0.00063	0.00315	0.99685	98,429	310	491,371	5,951,309	60.5
15	2,583,159	4,961	0.00192	0.00956	0.99044	98,119	938	488,251	5,459,938	55.6
20	2,801,153	7,397	0.00264	0.01312	0.98688	97,181	1,275	482,720	4,971,687	51.2
25	2,873,201	11,895	0.00414	0.02049	0.97951	95,907	1,965	474,621	4,488,967	46.8
30	2,918,377	16,259	0.00557	0.02747	0.97253	93,942	2,581	463,257	4,014,345	42.7
35	2,755,005	15,416	0.00560	0.02759	0.97241	91,361	2,521	450,502	3,551,089	38.9
40	2,386,633	14,211	0.00595	0.02934	0.97066	88,840	2,606	437,684	3,100,587	34.9
45	1,950,168	13,592	0.00697	0.03425	0.96575	86,234	2,954	423,785	2,662,902	30.9
50	1,489,348	13,672	0.00918	0.04487	0.95513	83,280	3,737	407,059	2,239,117	26.9
55	1,060,733	13,421	0.01265	0.06132	0.93868	79,543	4,878	385,523	1,832,058	23.0
60	983,588	16,349	0.01662	0.07979	0.92021	74,666	5,958	358,433	1,446,535	19.4
65	781,977	18,895	0.02416	0.11393	0.88607	68,708	7,828	323,969	1,088,102	15.8
70	536,323	21,603	0.04028	0.18297	0.81703	60,880	11,139	276,550	764,134	12.6
75	309,826	18,915	0.06105	0.26483	0.73517	49,740	13,173	215,769	487,584	9.8
80	159,815	15,243	0.09538	0.38508	0.61492	36,567	14,081	147,634	271,815	7.4
85	80,327	11,802	0.14693	0.53729	0.46271	22,486	12,082	82,227	124,181	5.5
90	30,939	6,907	0.22324	0.71639	0.28361	10,405	7,454	33,389	41,954	4.0
95	14,150	4,734	0.33458	0.91095	0.08905	2,951	2,688	8,034	8,565	2.9
100+	18,074	8,939	0.49456	1.00000	0.00000	263	263	531	531	2.0
FEMALES										
0	368,302	2,277	0.00618	0.00616	0.99384	100,000	616	99,569	7,538,572	75.4
1	1,706,358	1,873	0.00110	0.00438	0.99562	99,384	435	396,664	7,439,004	74.9
5	2,429,542	1,513	0.00062	0.00311	0.99689	98,948	308	493,973	7,042,339	71.2
10	2,352,588	1,004	0.00043	0.00213	0.99787	98,641	210	492,678	6,548,367	66.4
15	2,468,136	1,478	0.00060	0.00299	0.99701	98,430	294	491,416	6,055,689	61.5
20	2,726,135	2,827	0.00104	0.00517	0.99483	98,136	508	489,412	5,564,273	56.7
25	2,843,679	6,131	0.00216	0.01072	0.98928	97,629	1,047	485,526	5,074,861	52.0
30	2,968,705	6,702	0.00226	0.01122	0.98878	96,582	1,084	480,199	4,589,336	47.5
35	2,845,098	6,106	0.00215	0.01067	0.98933	95,498	1,019	474,940	4,109,137	43.0
40	2,475,868	6,270	0.00253	0.01258	0.98742	94,478	1,189	469,420	3,634,197	38.5
45	2,069,609	7,174	0.00347	0.01718	0.98282	93,290	1,603	462,440	3,164,777	33.9
50	1,590,820	8,131	0.00511	0.02523	0.97477	91,686	2,314	452,648	2,702,337	29.5
55	1,142,306	8,688	0.00761	0.03732	0.96268	89,373	3,335	438,526	2,249,689	25.2
60	1,092,341	11,573	0.01059	0.05161	0.94839	86,038	4,440	419,088	1,811,163	21.1
65	916,620	14,944	0.01630	0.07832	0.92168	81,598	6,391	392,010	1,392,075	17.1
70	665,618	21,646	0.03252	0.15037	0.84963	75,206	11,309	347,760	1,000,065	13.3
75	411,820	22,082	0.05362	0.23641	0.76359	63,897	15,106	281,722	652,305	10.2
80	231,093	20,697	0.08956	0.36588	0.63412	48,791	17,852	199,328	370,583	7.6
85	126,027	18,249	0.14480	0.53157	0.46843	30,940	16,447	113,582	171,256	5.5
90	50,485	11,437	0.22654	0.72315	0.27685	14,493	10,481	46,264	57,674	4.0
95	21,683	7,439	0.34309	0.92341	0.07659	4,012	3,705	10,799	11,410	2.8
100+	24,980	12,564	0.50295	1.00000	0.00000	307	307	611	611	2.0

Source: Author’s calculations

Table 6.3: Period life table for Thailand 2007

Age at start of interval	Mid-year population	Number of Deaths	Central Death rate	Probability of Dying between age x to x+n	Probability of Surviving between age x to x+n	Number of Surviving to age x	Number of Deaths between age x to x+n	Person Years lived in age interval between age x to x+n	Total Numbers of years lived from age x	Total Life Expectancy
x	$_nP_x$	$_nD_x$	$_nM_x$	$_nq_x$	$_np_x$	l_x	$_nd_x$	$_nL_x$	T_x	e_x
MALES										
0	393,881	3,272	0.00831	0.00827	0.99173	100,000	827	99,421	7,155,699	71.6
1	1,662,732	1,276	0.00077	0.00307	0.99693	99,173	304	396,082	7,056,279	71.2
5	2,218,705	1,187	0.00054	0.00267	0.99733	98,869	264	493,682	6,660,196	67.4
10	2,533,530	1,504	0.00059	0.00296	0.99704	98,604	292	492,292	6,166,514	62.5
15	2,455,389	4,576	0.00186	0.00927	0.99073	98,312	912	489,282	5,674,222	57.7
20	2,493,415	5,138	0.00206	0.01025	0.98975	97,400	998	484,506	5,184,941	53.2
25	2,707,630	6,830	0.00252	0.01253	0.98747	96,402	1,208	478,989	4,700,435	48.8
30	2,736,915	9,174	0.00335	0.01662	0.98338	95,194	1,582	472,013	4,221,446	44.3
35	2,765,000	11,209	0.00405	0.02007	0.97993	93,612	1,878	463,361	3,749,433	40.1
40	2,599,575	13,349	0.00514	0.02535	0.97465	91,733	2,325	452,852	3,286,072	35.8
45	2,238,123	15,092	0.00674	0.03316	0.96684	89,408	2,964	439,627	2,833,220	31.7
50	1,820,124	15,753	0.00865	0.04236	0.95764	86,443	3,662	423,062	2,393,593	27.7
55	1,370,622	16,905	0.01233	0.05982	0.94018	82,782	4,952	401,527	1,970,531	23.8
60	957,834	16,806	0.01755	0.08404	0.91596	77,829	6,541	372,794	1,569,004	20.2
65	793,409	19,878	0.02505	0.11789	0.88211	71,288	8,404	335,432	1,196,210	16.8
70	597,005	21,515	0.03604	0.16530	0.83470	62,884	10,395	288,435	860,778	13.7
75	379,143	20,221	0.05333	0.23530	0.76470	52,490	12,351	231,572	572,342	10.9
80	192,252	15,186	0.07899	0.32983	0.67017	40,139	13,239	167,598	340,770	8.5
85	82,275	9,736	0.11833	0.45660	0.54340	26,900	12,282	103,794	173,172	6.4
90	31,597	5,667	0.17934	0.61912	0.38088	14,618	9,050	50,463	69,377	4.7
95	10,287	2,829	0.27499	0.81479	0.18521	5,568	4,536	16,497	18,914	3.4
100+	11,877	5,066	0.42655	1.00000	0.00000	1,031	1,031	2,417	2,417	2.3
FEMALES										
0	373,161	2,518	0.00675	0.00672	0.99328	100,000	672	99,529	7,812,340	78.1
1	1,562,120	930	0.00060	0.00238	0.99762	99,328	236	396,837	7,712,811	77.7
5	2,090,892	801	0.00038	0.00191	0.99809	99,091	190	494,982	7,315,974	73.8
10	2,395,156	945	0.00039	0.00197	0.99803	98,902	195	494,021	6,820,992	69.0
15	2,333,403	1,240	0.00053	0.00265	0.99735	98,707	262	492,878	6,326,971	64.1
20	2,429,261	1,547	0.00064	0.00318	0.99682	98,445	313	491,441	5,834,092	59.3
25	2,662,027	2,620	0.00098	0.00491	0.99509	98,132	482	489,455	5,342,651	54.4
30	2,757,964	3,761	0.00136	0.00680	0.99320	97,650	664	486,592	4,853,196	49.7
35	2,868,180	4,689	0.00163	0.00814	0.99186	96,987	790	482,959	4,366,605	45.0
40	2,743,756	5,879	0.00214	0.01066	0.98934	96,197	1,025	478,422	3,883,646	40.4
45	2,381,271	7,166	0.00301	0.01493	0.98507	95,172	1,421	472,306	3,405,224	35.8
50	1,988,256	8,876	0.00446	0.02207	0.97793	93,751	2,070	463,579	2,932,917	31.3
55	1,515,627	10,504	0.00693	0.03406	0.96594	91,681	3,123	450,598	2,469,338	26.9
60	1,079,097	11,599	0.01075	0.05234	0.94766	88,558	4,635	431,204	2,018,740	22.8
65	932,302	15,261	0.01637	0.07863	0.92137	83,923	6,599	403,119	1,587,536	18.9
70	751,493	18,853	0.02509	0.11803	0.88197	77,324	9,127	363,805	1,184,417	15.3
75	514,324	20,664	0.04018	0.18255	0.81745	68,198	12,449	309,865	820,612	12.0
80	283,172	18,722	0.06612	0.28369	0.71631	55,748	15,815	239,204	510,746	9.2
85	133,029	14,213	0.10684	0.42160	0.57840	39,933	16,836	157,576	271,543	6.8
90	53,548	9,079	0.16955	0.59539	0.40461	23,097	13,752	81,107	113,966	4.9
95	16,793	4,438	0.26426	0.79566	0.20434	9,345	7,436	28,138	32,859	3.5
100+	16,763	6,780	0.40448	1.00000	0.00000	1,910	1,910	4,721	4,721	2.5

Source: Author’s calculations

The life expectancy at old ages (60 and over) between 2002 and 2007 increased as well. Table 6.4 shows that increasing life expectancy at age 60 and over was found both for men and women. The increases of the old age life expectancy for females were greater than for males at all ages. The differences between gender show that elderly women tend to live longer than men at all ages in the period 2002 to 2007 except for ages 90 and over in 2002 when elderly men had a slightly higher life expectancy than elderly women at the same ages.

Table 6.4: The life expectancies and their changes for males and females for Thailand 2002 and 2007

Age	e_x Males			e_x Females		
	2002	2007	Change	2002	2007	Change
0	69.4	71.6	2.2	75.4	78.1	2.7
1	68.9	71.2	2.3	74.9	77.7	2.8
5	65.2	67.4	2.1	71.2	73.8	2.7
10	60.5	62.5	2.1	66.4	69.0	2.6
15	55.6	57.7	2.1	61.5	64.1	2.6
20	51.2	53.2	2.1	56.7	59.3	2.6
25	46.8	48.8	2.0	52.0	54.4	2.5
30	42.7	44.3	1.6	47.5	49.7	2.2
35	38.9	40.1	1.2	43.0	45.0	2.0
40	34.9	35.8	0.9	38.5	40.4	1.9
45	30.9	31.7	0.8	33.9	35.8	1.9
50	26.9	27.7	0.8	29.5	31.3	1.8
55	23.0	23.8	0.8	25.2	26.9	1.8
60	19.4	20.2	0.8	21.1	22.8	1.7
65	15.8	16.8	0.9	17.1	18.9	1.9
70	12.6	13.7	1.1	13.3	15.3	2.0
75	9.8	10.9	1.1	10.2	12.0	1.8
80	7.4	8.5	1.1	7.6	9.2	1.6
85	5.5	6.4	0.9	5.5	6.8	1.3
90	4.0	4.7	0.7	4.0	4.9	1.0
95	2.9	3.4	0.5	2.8	3.5	0.7
100+	2.0	2.3	0.3	2.0	2.5	0.5

Source: Author's calculations

However, life tables calculated by using number of deaths and mid-year population from Thailand Vital Registration provided different life expectancy from the WHO life table. These differences might result from the variation in method for calculating life table and/or the difference in estimating number of mid-year population and number of deaths. Re-computation the life table using the spreadsheet formulae (that implements the Rowland life table model) confirms that there are no differences by method, so the differences must be due to measurement of the age-specific mortality rates. These need to be traced back to the original data sources.

However, this indicates some uncertainty about the level of life expectancy in Thailand. We argue that our computations are likely to be more accurate as they are transparently based on Thailand deaths and population statistics. We suspect that international agencies such as WHO produce tables in a given year based on the latest available statistics for the country concerned, which may or may not be for the year of publication. However, this hypothesis has not been verified.

6.5 Health Prevalence

In this study, health prevalence rates are computed using the following indicators: self-rated health, self-care disability and mobility disability. These indicators are obtained from the Surveys of the Elderly in Thailand in 2002 and 2007, as discussed in Chapter 4.

The first indicator used is self-rated health. The elderly can rate their health into one of five categories which are very good, good, fair, poor and very poor. This study defines "Good Health" as very good combined with good whereas "Poor Health" refers to fair, poor and very poor.

Based on these definitions, the self-rated "Poor Health" prevalence rates (%) and their 95% confidence intervals are presented in Table 6.5. The poor health prevalence rates obtained from the Survey of Elderly in Thailand in 2002 and 2007 show that poor health prevalence increases when people get older. Poor health prevalence rate was lower than 50 percent in the younger old ages rising much more steeply in older old ages both for males and females.

The prevalence of poor health in older old age population was higher than 60 percent. When we compare between genders, elderly men tend to rate their health better than elderly women in the same age group. So the prevalence rates of poor health in elderly women were higher than prevalence rates of elderly men. The results in Table 6.5 show that the self-rated health of elderly men aged 60-64 to 80-84 worsened between 2002 and 2007. However, these worsening self- rated health changes are statistically insignificant at the 5% level. The self-rated health shows an improvement in elderly men aged 85 and over but the differences between the two years are statistically insignificant at the 5% level. Elderly women show an improvement of self-rated health in almost all age groups between 2002 and 2007 but the differences are statistically insignificant at 5% level (as presented in Table 6.5).

Table 6.5: The age specific prevalence rates and 95% confidence intervals of “Poor Health” by sex for the year 2002 and 2007, Thailand

Age	**Self -Rated Poor Health**				
	2002	**95% CI**	**2007**	**95% CI**	**Change**
Males					
50-54	23.5	22.3 - 24.7	27.4	26.3 - 28.5	3.9 *
55-59	29.0	27.6 - 30.4	32.3	31.0 - 33.6	3.3 *
60-64	36.8	35.2 - 38.4	39.9	38.4 - 41.4	3.1
65-69	44.0	42.2 - 45.8	46.3	44.6 - 48.0	2.3
70-74	54.1	51.9 - 56.3	53.4	51.5 - 55.3	-0.7
75-79	60.0	57.3 - 62.7	63.0	60.7 - 65.3	3.0
80-84	69.3	65.7 - 72.9	69.7	66.8 - 72.6	0.4
85-89	72.8	67.8 - 77.8	72.0	67.4 - 76.6	-0.8
90-94	78.2	70.1 - 86.3	75.2	67.5 - 82.9	-3.0
95+	74.3	59.8 - 88.8	70.7	59.0 - 82.4	-3.6
Females					
50-54	34.3	33.0 - 35.6	34.7	33.6 - 35.8	0.4
55-59	40.3	38.9 - 41.7	41.2	40.0 - 42.4	0.9
60-64	50.5	49.0 - 52.0	48.5	47.1 - 49.9	-2.0
65-69	55.7	54.0 - 57.4	55.3	53.8 - 56.8	-0.4
70-74	63.3	61.5 - 65.1	65.5	63.9 - 67.1	2.2
75-79	69.3	67.1 - 71.5	68.4	66.6 - 70.2	-0.9
80-84	75.5	72.8 - 78.2	73.8	71.5 - 76.1	-1.7
85-89	76.6	73.0 - 80.2	74.3	70.9 - 77.7	-2.3
90-94	78.5	72.7 - 84.3	74.4	69.0 - 79.8	-4.1
95+	82.7	75.4 - 90.0	81.0	73.9 - 88.1	-1.7

Source: Author’s calculations

Notes: “Poor Health” is fair, poor and very poor.

* = Statistically significant at 5% level.

The second set of health indicators we study involve self-care activities which measure the ability of the elderly to perform self-care activities including: Feeding, Dressing, and Bathing/Using toilet as presented in Chapter 4. The self-care disability was defined as the inability to perform at least one activity of the self-care activities. Then, the elderly who can perform all three self-care activities were classified as “self-care active”.

Based on these definitions, the self-care disability prevalence rates (%) and their 95% confidence intervals are presented in Table 6.6. The self-care disability prevalence rates obtained from the Surveys of Elderly in Thailand in 2002 and 2007 show that self-care disability tends to increase with age both for men and women. Elderly men tend to report lower self-care disability than elderly women in the same age group. So the prevalence rates of self-care disability in elderly women were higher than prevalence rates of elderly men.

Table 6.6: Prevalence rates of self-care disability by age and sex for Thailand, 2002 and 2007.

Age	Self -Care Disability				
	2002	**95% CI**	**2007**	**95% CI**	**Change**
Males					
50-54	0.7	0.5 - 0.9	0.8	0.6 - 1.0	0.1
55-59	0.6	0.4 - 0.9	1.0	0.7 - 1.3	0.4
60-64	1.1	0.8 - 1.5	1.7	1.3 - 2.1	0.6
65-69	1.8	1.3 - 2.3	2.0	1.5 - 2.5	0.2
70-74	2.8	2.1 - 3.5	3.1	2.4 - 3.8	0.3
75-79	4.3	3.2 - 5.4	4.3	3.3 - 5.3	0.0
80-84	7.3	5.2 - 9.4	8.8	7.0 - 10.6	1.5
85-89	7.8	4.8 - 10.8	13.5	10.0 - 17.0	5.7
90-94	14.0	7.2 - 20.8	26.1	18.2 - 34.0	12.1
95+	14.3	2.7 - 25.9	20.7	9.7 - 31.7	6.4
Females					
50-54	0.5	0.3 - 0.7	0.6	0.4 - 0.8	0.1
55-59	0.8	0.5 - 1.1	0.9	0.7 - 1.1	0.1
60-64	1.1	0.8 - 1.4	1.4	1.1 - 1.7	0.3
65-69	1.5	1.1 - 1.9	1.7	1.3 - 2.1	0.2
70-74	3.0	2.4 - 3.7	3.4	2.8 - 4.0	0.4
75-79	4.7	3.7 - 5.7	5.2	4.3 - 6.9	0.5
80-84	8.1	6.4 - 9.8	11.3	9.7 - 12.9	3.2
85-89	13.7	10.7 - 16.7	20.5	17.4 - 23.6	6.8 *
90-94	27.9	21.4 - 34.4	33.2	27.4 - 39.0	5.3
95+	21.8	13.8 - 29.9	40.5	31.6 - 49.4	18.7 *

Source: Author’s calculations
Note: * = Statistically significant at 5% level.

The results in Table 6.6 show that the self-care disability of elderly men in all age groups except elderly men aged 75-79 increased between 2002 and 2007. However, these rising self-care disability rates are statistically insignificant at the 5% level. The differences in self-care disability also show an increase in disability prevalence in elderly women in all age groups between 2002 and 2007. The differences between the two years are statistically insignificant at the 5% level except for age group 85-89.

The third set of health indicators we study involve mobility activities which measure the ability of the elderly to perform mobility activities including: Squatting, Carrying a weight of 5 kgs, Climbing 2-3 flights of stairs and Taking public transport as presented in Chapter 4. The mobility dependence was defined as the inability to perform at least one activity of the mobility activities. Then, elderly who can perform all four mobility activities were classified as “mobility active”.

Based on these definitions, the mobility dependence prevalence rates (%) and their 95% confidence intervals are presented in Table 6.7. The mobility dependence prevalence rates obtained from the Survey of Elderly in Thailand in 2002 and 2007 show that mobility dependence tends to increase with age both for men and women. Elderly men tend to report lower mobility dependence than elderly women in the same age group. So the prevalence rates of mobility dependence in elderly women were higher than prevalence rates of elderly men. The results in Table 6.7 show that the mobility dependence of elderly men decreased in all age groups between 2002 and 2007 except elderly men aged 90-94 and 95-99 who reported increasing mobility dependence. These decreases of mobility dependence are statistically significant at 5% level. The differences in mobility dependence also show an improvement of mobility dependence in elderly women in all age groups between 2002 and 2007 except age group 95-99. The differences between two years are statistically significant at the 5% level except for age group 80-84 to 95-99.

The prevalence rates as presented above confirm that the health trends in old age depends on the health indicators applied. However, we can put forward some generalisations. Health status in the elderly population of Thailand worsens with increasing age both for men and women. Gender differences in health status are found for all health indicators. Men reported better health or less dependence than women in the same age group. Based on all three health indicators which measured the health of elderly Thai, there are some fluctuations in the health prevalence rates for the population aged 90 and over. The fluctuation in prevalence rates of good health are also found in the health of the Austrian elderly population between 1978 and 1998. Healthy life expectancy for this period was computed by excluding the population aged 90 and over (Doblhammer and Kytir 2001). We follow this practice, then the health prevalence rates of the population age 90 and over will be excluded from the health modelling stage of the Thailand healthy life expectancy calculation (Section 6.6).

Table 6.7: Prevalence rates of mobility dependence by age and sex for Thailand, 2002 and 2007.

Age	Mobility Disability				
	2002	**95% CI**	**2007**	**95% CI**	**Change**
Males					
50-54	4.4	3.8 - 5.0	3.3	2.9 - 3.7	-1.1 *
55-59	6.9	6.1 - 7.7	5.1	4.5 - 5.7	-1.8 *
60-64	14.6	13.4 - 15.8	10.7	9.8 - 11.7	-3.9 *
65-69	23.9	22.3 - 25.5	16.3	15.0 - 17.6	-7.6 *
70-74	43.8	41.6 - 46.0	30.6	28.8 - 32.4	-13.2 *
75-79	56.4	53.6 - 59.2	43.2	40.9 - 45.5	-13.2 *
80-84	71.1	67.4 - 74.8	60.7	57.6 - 63.8	-10.4 *
85-89	82.0	77.6 - 86.4	72.2	67.6 -76.8	-9.8 *
90-94	85.6	78.6 - 92.6	87.4	81.4 - 93.4	1.8
95+	80.0	66.8 - 93.3	82.1	72.1 - 92.1	2.1
Females					
50-54	11.6	10.7 - 12.5	6.9	6.3 - 7.5	-4.7 *
55-59	18.1	17.0 - 19.3	12.1	11.3 - 12.9	-6.0 *
60-64	33.9	32.4 - 35.4	22.2	21.0 - 23.4	-11.7 *
65-69	47.5	45.8 - 49.2	32.2	30.8 - 33.6	-15.3 *
70-74	66.4	64.6 - 68.2	52.9	51.3 - 54.5	-13.5 *
75-79	76.9	74.8 - 79.0	62.5	60.6 - 64.4	-14.4 *
80-84	81.9	79.4 - 84.4	79.4	77.3 - 81.5	-2.5
85-89	89.9	87.3 - 92.5	87.7	85.2 - 90.2	-2.2
90-94	93.4	89.8 - 97.0	93.3	90.2 - 96.4	-0.1
95+	92.9	87.8 - 98.0	93.5	88.5 - 98.5	0.6

Source: Author’s calculations

Note: * = Statistically significant at 5% level.

6.6 The Sullivan Method for Constructing a Healthy Life Table

This section reports on healthy life expectancy calculated using the Sullivan method. The healthy life expectancy calculated by this method is the number of remaining years at a particular age which an individual can expect to live in good health (defined in Section 6.5). The data required for the calculation are the age–specific morbidity or disability prevalence (in this section, the poor health prevalence rate is used as the example), which were obtained from the 2002 and 2007 Surveys of the Elderly in Thailand. The total person years lived at a particular age was derived from Thailand period life tables. To calculate a life table, number of deaths and number of mid-year population by age are needed as discussed in Section 6.3. Data provided by The Ministry of Public Health, Thailand are used. The method is described as follows.

6.6.1 Estimated Prevalence Rates below Age 50

To calculate healthy life expectancy, the poor health prevalence rates for all ages are needed. However, the health prevalence rates from the Survey of Elderly in Thailand are for age range 50-54 to 100 and over. These are shown in Table 6.8. Health prevalence rates for age range 0 to 45-49 are those obtained by fitting an exponential model to age range 50-54 to 85 to 89. The prevalence rates for age group 90 and over are excluded from the model due to the fluctuation of their health prevalence rates as explained in Section 6.5.

Table 6.8: The observed poor health prevalence rates for Thailand, 2007

Age	**Poor Health Prevalence (%)**	
	Males	**Females**
50-54	27.4	34.7
55-59	32.3	41.2
60-64	39.9	48.5
65-69	46.3	55.3
70-74	53.4	65.5
75-79	63.0	68.4
80-84	69.7	73.8
85-89	72.0	74.3

Source: Author’s calculations

The following model is fitted to the prevalence rates in Table 6.8 using the mid-age for each age interval.

$$y = ae^{bx} \quad (6.15)$$

The value of the intercept, a, is 6.3494, the slope, b, is 0.0289 and the correlation is 0.9882 for males whereas the intercept for females is 11.5640, the slope is 0.0225 and the correlation is 0.9697. Then we used Equation 6.15 to calculate disability prevalence for x = 0 to 45-49 as shown in Table 6.9.

Table 6.9: Observed and modelled poor health prevalence rates and the prevalence rates used in calculation of healthy life expectancy for Thailand, 2007.

Age	**Males**			**Females**		
	Observed Prevalence Rates (%)	**Modelled Prevalence Rates (%)**	**Proportion of Poor Health**	**Observed Prevalence Rates (%)**	**Modelled Prevalence Rates (%)**	**Proportion of Poor Health**
0	-	6.4	0.064	-	11.7	0.117
1-4	-	6.9	0.069	-	12.4	0.124
5-9	-	7.9	0.079	-	13.7	0.137
⋮	⋮	⋮	⋮	⋮	⋮	⋮
45-49	-	25.0	0.025	-	33.7	0.337
50-54	27.4	-	0.274	34.7	-	0.347
55-59	32.3	-	0.323	41.2	-	0.412
⋮	⋮	⋮	⋮	⋮	⋮	⋮
85-89	72.0	-	0.720	74.3	-	0.743
90-94	75.2	-	0.752	74.4	-	0.744
95-99	67.3	-	0.673	78.5	-	0.785
100+	100.0	-	1.000	91.3	-	0.913

Source: Author's calculations

The extrapolations of health prevalence rates using Equation 6.15 provide reasonable results. Because the comparison between the observed disability prevalence by age groups obtained from The 2007 Survey of Disability (NSO 2007b) and the modelled disability prevalence rates obtained from this study show the same trends (Figure 6.1). However, the disabled person from The 2007 Survey of Disability was defined as the person who has activity limitation or impairment which is different from the disability definition in this study.

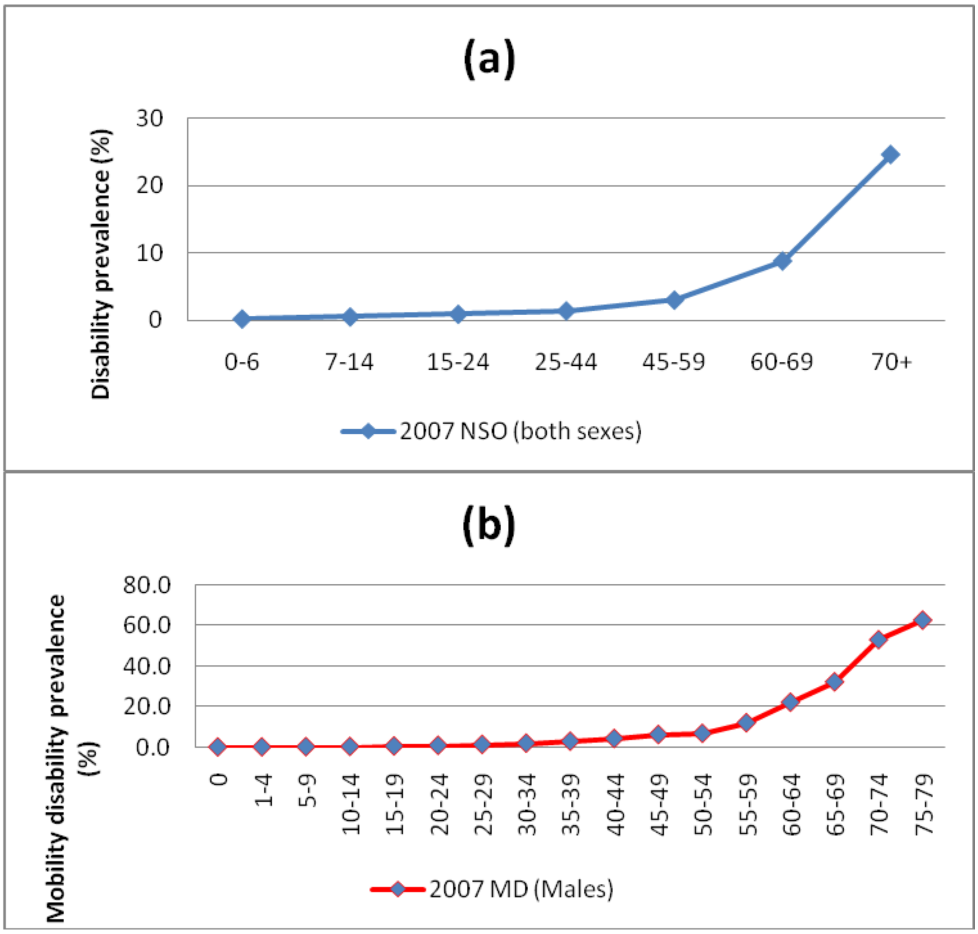


Figure 6.1: (a) Disability prevalence rates in both sexes obtained from The 2007 Survey of Disability and (b) mobility disability prevalence rates for males in 2007 obtained from The 2007 Survey of Elderly in Thailand (ages 50 and over) and modelled prevalence (ages 0-49).

6.6.2 Person Years Lived With Good Health and Poor Health

To compute person years lived with good health and poor health, the person years lived between ages x and x+n (${}_nL_x$) is multiplied by the proportion of people with good health and poor health at these ages. The proportion of people with good health is simply 1-proportion of people with poor health

$$ {}_nL_x^{GH} = {}_nGH_x \times {}_nL_x \quad (6.16) $$

$$ {}_nL_x^{PH} = {}_nPH_x \times {}_nL_x \quad (6.17) $$

6.6.3 Total Number of Years Lived with Good Health and Poor Health

Total number of years lived with good health at age x is calculated by summing the person years lived with good health at age x to age 100 and over:

$$T_x^{GH} = \sum_x^{100} {}_{n}L_x^{GH} \qquad (6.18)$$

$$T_x^{PH} = \sum_x^{100} {}_{n}L_x^{PH} \qquad (6.19).$$

6.6.4 Healthy Life Expectancy (HLE)

Healthy life expectancy at age x is calculated by dividing the total number of years lived with good health or poor health at age x by the number of the hypothetical radix surviving at exact ages (l_x)

$$e_x^{GH} = T_x^{GH}/l_x \qquad (6.20)$$

$$e_x^{PH} = T_x^{PH}/l_x \qquad (6.21)$$

The results on calculating healthy life expectancy as illustrated in section 6.6 are shown in Table 6.10.

6.7 Healthy Life Expectancy: The Results from the Surveys of Elderly in Thailand

The healthy life expectancies for the elderly in Thailand in 2002 and 2007 are calculated as presented above. The method for computing healthy life expectancy, described in Section 6.6, was a general one. This study used this method to compute healthy life expectancy using three different poor health indicators: self-rated poor health, self-care disability and mobility disability. The calculation for healthy life expectancy for Thailand based on these three health indicators are presented in Appendix A.

Table 6.10: Thailand life table with healthy life expectancy 2007

Age at start of interval	Person Years lived in age interval between age x to x+n	Total Numbers of years lived from age x	Total Life Expectancy	Proportion with poor health	Proportion with good health	Person years lived with good health in age interval	Total years lived with good health from age x	Good Health Life Expectancy	Poor Health Life Expectancy
x	$_nL_x$	T_x	e_x	$_nPH_x$	$_nGH_x$	$(_nGH_x)_nL_x$	$\Sigma(_nGH_x)_nL_x$	$GHLE_x$	$PHLE_x$
Males									
0	99421	7155699	71.6	0.064418	0.935582	93016	5396503	54.0	17.6
1	396082	7056279	71.2	0.069237	0.930763	368659	5303487	53.5	17.7
5	493682	6660196	67.4	0.078839	0.921161	454761	4934828	49.9	17.5
10	492292	6166514	62.5	0.091078	0.908922	447455	4480067	45.4	17.1
15	489282	5674222	57.7	0.105216	0.894784	437801	4032613	41.0	16.7
20	484506	5184941	53.2	0.121550	0.878450	425614	3594811	36.9	16.3
25	478989	4700435	48.8	0.140418	0.859582	411730	3169197	32.9	15.9
30	472013	4221446	44.3	0.162216	0.837784	395445	2757467	29.0	15.4
35	463361	3749433	40.1	0.187397	0.812603	376529	2362022	25.2	14.8
40	452852	3286072	35.8	0.216488	0.783512	354815	1985494	21.6	14.2
45	439627	2833220	31.7	0.250094	0.749906	329679	1630679	18.2	13.5
50	423062	2393593	27.7	0.274000	0.726000	307143	1301000	15.1	12.6
55	401527	1970531	23.8	0.323000	0.677000	271834	993857	12.0	11.8
60	372794	1569004	20.2	0.399000	0.601000	224049	722023	9.3	10.9
65	335432	1196210	16.8	0.463000	0.537000	180127	497974	7.0	9.8
70	288435	860778	13.7	0.534000	0.466000	134411	317847	5.1	8.6
75	231572	572342	10.9	0.630000	0.370000	85682	183436	3.5	7.4
80	167598	340770	8.5	0.697000	0.303000	50782	97754	2.4	6.1
85	103794	173172	6.4	0.720000	0.280000	29062	46972	1.7	4.7
90	50463	69377	4.7	0.752000	0.248000	12515	17909	1.2	3.5
95	16497	18914	3.4	0.673000	0.327000	5394	5394	1.0	2.4
100+	2417	2417	2.3	1.000000	0.000000	0	0	0.0	2.3
Females									
0	99529	7812340	78.1	0.116948	0.883052	87890	5165751	51.7	26.5
1	396837	7712811	77.7	0.123711	0.876289	347744	5077861	51.1	26.5
5	494982	7315974	73.8	0.136885	0.863115	427226	4730117	47.7	26.1
10	494021	6820992	69.0	0.153175	0.846825	418349	4302891	43.5	25.5
15	492878	6326971	64.1	0.171404	0.828596	408397	3884542	39.4	24.7
20	491441	5834092	59.3	0.191802	0.808198	397182	3476145	35.3	24.0
25	489455	5342651	54.4	0.214627	0.785373	384405	3078963	31.4	23.1
30	486592	4853196	49.7	0.240169	0.759831	369728	2694558	27.6	22.1
35	482959	4366605	45.0	0.268750	0.731250	353164	2324830	24.0	21.1
40	478422	3883646	40.4	0.300732	0.699268	334545	1971667	20.5	19.9
45	472306	3405224	35.8	0.336520	0.663480	313366	1637121	17.2	18.6
50	463579	2932917	31.3	0.347000	0.653000	302717	1323756	14.1	17.2
55	450598	2469338	26.9	0.412000	0.588000	264952	1021039	11.1	15.8
60	431204	2018740	22.8	0.485000	0.515000	222070	756087	8.5	14.3
65	403119	1587536	18.9	0.553000	0.447000	180194	534017	6.4	12.6
70	363805	1184417	15.3	0.655000	0.345000	125513	353823	4.6	10.7
75	309865	820612	12.0	0.684000	0.316000	97917	228310	3.3	8.7
80	239204	510746	9.2	0.738000	0.262000	62671	130392	2.3	6.8
85	157576	271543	6.8	0.743000	0.257000	40497	67721	1.7	5.1
90	81107	113966	4.9	0.744000	0.256000	20763	27224	1.2	3.8
95	28138	32859	3.5	0.785000	0.215000	6050	6460	0.7	2.8
100+	4721	4721	2.5	0.913000	0.087000	411	411	0.2	2.3

Source: Author’s calculations

6.7.1 Self-rated Healthy Life Expectancy (SRHLE)

Healthy life expectancy based on self-rated health is presented in Table 6.11. The results show that healthy life expectancy decreased when people get older for both men and women. However, healthy life expectancy for women was lower than men in all ages although the life expectancy for women shows that elderly women tend to live longer than men. This trend was found in both 2002 and 2007. Elderly women aged 65 are expected to live another 5.8 years in good health while elderly men aged 65 could expect to live in good health for 6.9 years in 2002.

Table 6.11: Life Expectancy, Self-rated Healthy Life Expectancy (SRHLE), Health Ratio (SRHLE/LE) and their 95% Confidence Interval by sex for Thailand 2002 and 2007

Age	LE 2002	LE 2007	Change and Direction of Change in LE	SRHLE and 95% CI 2002	SRHLE and 95% CI 2007	Change and Direction of Change in SRHLE	SRHLE/LE(%) and 95% CI 2002	SRHLE/LE(%) and 95% CI 2007	Change and Direction of Change in SRHL/LE
Males									
60	19.4	20.2	0.8	9.4 (9.2-9.5)	9.3 (9.1-9.5)	-0.1	48.3 (48.1-48.4)	46.0 (45.9-46.2)	-2.3 *
65	15.8	16.8	0.9	6.9 (6.7-7.1)	7.0 (6.8-7.2)	0.1	43.4 (43.2-43.5)	41.6 (41.5-41.7)	-1.7 *
70	12.6	13.7	1.1	4.8 (4.6-5.0)	5.1 (4.9-5.2)	0.3	38.0 (37.9-38.1)	36.9 (36.8-37.1)	-1.1 *
75	9.8	10.9	1.1	3.3 (3.1-3.5)	3.5 (3.3-3.7)	0.2	33.5 (33.4-33.6)	32.1 (31.9-32.2)	-1.4 *
80	7.4	8.5	1.1	2.1 (1.9-2.3)	2.4 (2.2-2.6)	0.3	28.3 (28.2-28.5)	28.7 (28.5-28.8)	0.3 *
85	5.5	6.4	0.9	1.4 (1.2-1.6)	1.7 (1.5-2.0)	0.3	25.5 (25.4-25.7)	27.1 (26.9-27.3)	1.6 *
90	4.0	4.7	0.7	0.9 (0.6-1.2)	1.2 (0.9-1.5)	0.3	22.3 (22.0-22.5)	25.8 (25.6-26.1)	3.5 *
95	2.9	3.4	0.5	0.7 (0.3-1.1)	1.0 (0.6-1.4)	0.3	24.1 (23.7-24.7)	28.5 (28.2-28.8)	4.4 *
Females									
60	21.1	22.8	1.7	7.9 (7.8-8.1)	8.5 (8.4-8.7)	0.6 *	37.7 (37.6-37.8)	37.5 (37.3-37.6)	-0.2 *
65	17.1	18.9	1.9	5.8 (5.7-6.0)	6.4 (6.2-6.5)	0.5 *	34.1 (34.0-34.2)	33.6 (33.5-33.7)	-0.5 *
70	13.3	15.3	2.0	4.0 (3.9-4.2)	4.6 (4.4-4.7)	0.6 *	30.1 (30.0-30.2)	29.9 (29.8-30.0)	-0.3 *
75	10.2	12.0	1.8	2.7 (2.6-2.9)	3.3 (3.2-3.5)	0.6 *	26.6 (26.5-26.7)	27.8 (27.7-27.9)	1.2 *
80	7.6	9.2	1.6	1.8 (1.6-1.9)	2.3 (2.2-2.5)	0.6 *	23.5 (23.4-23.6)	25.5 (25.4-25.6)	2.0 *
85	5.5	6.8	1.3	1.2 (1.1-1.4)	1.7 (1.5-1.9)	0.5 *	22.4 (22.3-22.5)	24.9 (24.8-25.1)	2.5 *
90	4.0	4.9	1.0	0.8 (0.6-1.0)	1.2 (1.0-1.4)	0.4	20.5 (20.4-20.6)	23.9 (23.7-24.1)	3.4 *
95	2.8	3.5	0.7	0.5 (0.3-0.7)	0.7 (0.4-1.0)	0.2	16.4 (16.2-16.5)	19.7 (19.5-19.9)	3.3 *

Source: Author's calculations
Note: * = Statistically significant change between 2002 and 2007 at 5% level.

The difference in healthy life expectancy between genders tends to reduce when the population gets older except for the population aged 90 and over. The proportions of healthy life expectancy to total life expectancy for elderly men were higher than women at all ages. Elderly men aged 65 in 2002 could expect to spend 43.4 percent of their remaining life in good health while elderly women aged 65 would expect to spend only 34.1 percent of the remaining life in good health. These results imply that elderly women tend to live longer than men but in worse health.

The results in Table 6.11 show that life expectancy improved both for men and women in all ages between 2002 and 2007. The healthy life expectancy based on self-rated health also improved in this period both for men and women. Elderly men aged 65 and over in 2002 could expect to live in good health for 6.9 years while in 2007 the elderly men in this age are expected to spend 7.0 years in good health. There is 0.1 year improvement in life spent in good health in this period. The increase in healthy life expectancy between 2002 and 2007 is reported for elderly women as well. Elderly women aged 65 and over in 2002 are expected to live another 5.8 years in good health while in 2007 they are expected to have 6.4 years in good health. Although the improvement in healthy life expectancy is found both for elderly men and women, the differences in healthy life expectancy between 2002 and 2007 for elderly men are statistically insignificant for all ages. The increase in healthy life expectancy for elderly women are statistically significant at ages 60 to 85 as presented in Table 6.11.

Because life expectancy and healthy life expectancy both increased in general between 2002 and 2007, the health ratio or proportion of healthy life expectancy to total life expectancy was measured to indicate whether the elderly live longer (total life expectancy increases) with good or poor health. The differences in health ratios in Table 6.11 show that the proportion of life spent in good health decreases for the elderly from age 60 to age 79. The proportion of life spent in good health for elderly men aged 65 reduced from 43.4 percent in 2002 to 41.6 percent in 2007. This trend was found in elderly women as the proportion of life spent in good health of elderly aged 65 decreased from 34.1 percent in 2002 to 33.6 percent in 2007. These declines of proportion of life spent in good health are statistically significant. However, the trend of the proportion of life spent in good health based on self-rated health is reversed for older old men and women. The proportion of life spent in good health for elderly persons aged 80 and over tends to increase. The proportion of life spent in good health of elderly men aged 80 rose from 28.3 percent to 28.7 percent from 2002 to 2007 whereas the proportion of elderly women in good health in the same age increased from 23.5 percent to 25.5 percent. These increases in proportion of life spent in good health in aged 80 and over are all statistically significant.

6.7.2 Self-care Disability Free Life Expectancy (SCDFLE)

Self-care disability free life expectancy is presented in Table 6.12. The results show that disability free life expectancy based on self-care decreased when people get older for both men and women. The self-care disability free life expectancy for elderly women tends to be greater than for men for ages 60-79 both in 2002 and 2007.

Table 6.12: Life Expectancy, Self-care Disability Free Life Expectancy (SCDFLE), Health Ratio (SCDFLE/LE) and their 95% Confidence Interval by sex for Thailand 2002 and 2007

Age	LE 2002	LE 2007	Change and Direction of Change in LE	SCDFLE and 95% CI 2002	SCDFLE and 95% CI 2007	Change and Direction of Change in SCDFLE	SCDFLE/LE(%) and 95% CI 2002	SCDFLE/LE(%) and 95% CI 2007	Change and Direction of Change in SCDFL/LE
Males									
60	19.4	20.2	0.8	18.7 (18.6-18.8)	19.2 (19.1-19.3)	0.5 *	96.5 (96.5-96.6)	95.0 (94.9-95.1)	-1.5 *
65	15.8	16.8	0.9	15.2 (15.1-15.3)	15.8 (15.7-15.9)	0.6 *	95.8 (95.7-95.9)	94.0 (93.9-94.1)	-1.8 *
70	12.6	13.7	1.1	11.9 (11.8-12.0)	12.7 (12.5-12.8)	0.8 *	94.7 (94.6-94.8)	92.5 (92.4-92.6)	-2.2 *
75	9.8	10.9	1.1	9.2 (9.0-9.3)	9.8 (9.7-10.0)	0.7 *	93.3 (93.2-93.5)	90.2 (90.1-90.4)	-3.1 *
80	7.4	8.5	1.1	6.8 (6.7-6.9)	7.3 (7.2-7.5)	0.5 *	91.5 (91.4-91.6)	86.5 (86.4-86.7)	-5.0 *
85	5.5	6.4	0.9	5.0 (4.8-5.1)	5.3 (5.1-5.5)	0.3	90.0 (89.9-90.2)	82.0 (81.8-82.2)	-8.0 *
90	4.0	4.7	0.7	3.5 (3.2-3.7)	3.6 (3.3-3.9)	0.1	85.7 (85.5-86.0)	75.2 (74.9-75.4)	-10.5 *
95	2.9	3.4	0.5	2.5 (2.1-2.8)	2.7 (2.3-3.9)	0.2	84.7 (84.4-85.0)	78.6 (78.3-78.9)	-6.1 *
Females									
60	21.1	22.8	1.7	20.1 (20.0-20.2)	21.2 (21.1-21.3)	1.1 *	95.5 (95.4-95.6)	93.0 (92.9-93.1)	-2.5 *
65	17.1	18.9	1.9	16.1 (16.0-16.2)	17.3 (17.2-17.4)	1.2 *	94.5 (94.4-94.6)	91.5 (91.4-91.6)	-3.0 *
70	13.3	15.3	2.0	12.4 (12.3-12.5)	13.7 (13.6-13.8)	1.3 *	92.9 (92.8-93.0)	89.2 (89.1-89.3)	-3.7 *
75	10.2	12.0	1.8	9.3 (9.2-9.4)	10.3 (10.2-10.5)	1.1 *	90.7 (90.6-90.8)	85.9 (85.8-86.0)	-4.8 *
80	7.6	9.2	1.6	6.6 (6.5-6.7)	7.4 (7.2-7.5)	0.8 *	87.2 (87.2-87.3)	80.5 (80.4-80.7)	-6.7 *
85	5.5	6.8	1.3	4.5 (4.4-4.7)	5.0 (4.8-5.2)	0.5 *	81.8 (81.7-81.9)	73.3 (73.2-73.5)	-8.5 *
90	4.0	4.9	1.0	2.9 (2.7-3.1)	3.2 (3.0-3.4)	0.3	73.0 (72.8-73.1)	64.8 (64.7-65.0)	-8.2 *
95	2.8	3.5	0.7	2.2 (2.0-2.4)	2.1 (1.8-2.4)	-0.1	76.6 (76.4-76.8)	60.0 (59.8-60.2)	-16.6 *

Source: Author's calculations
Note: * = Statistically significant of change between 2002 and 2007 at 5% level.

In 2002, elderly men aged 65 were expected to live free from disability 15.2 years whereas 16.1 years of the remaining life for elderly women aged 65 was expected to be spent free from disability. In 2007, the disability free life expectancy for women at ages 60-79 was also greater than men. Although disability free life expectancy based on self-care for elderly women was greater than men at some ages, the total life expectancy of elderly women was greater than elderly men at all ages. The comparison of the difference in disability free life expectancy for elderly men and women needs to take into account the increase of total life expectancy. This can be explored by using the proportion of expected years free from disability.

The results in Table 6.12 show that the proportions of expected years free from self-care disability in elderly men were higher than women in all ages. In 2002, the elderly men aged 65 had 95.8 percent of their life expectancy free from self-care disability whereas only 94.5 percent was found for elderly women of the same age. These differences in proportion of expected years free from disability were also found in 2007. Elderly men aged 65 in 2007 are expected to have 94.0 percent of their life expectancy free from self-care disability while 91.5 percent of women total life expectancy was spent in disability free. These imply that elderly women tend to live longer than men but in worse health.

The results in Table 6.12 also show that the self-care disability free life expectancy improved both for men and women in all ages between 2002 and 2007. Elderly men aged 65 in 2002 could expect to live disability free for 15.2 years while in 2007 the elderly men at this age are expected to spend 15.8 years free from disability. There is 0.6 year improvement in disability free life in this period. The increase in disability free life expectancy between 2002 and 2007 is reported for elderly women as well. The elderly women aged 65 in 2002 are expected to live another 16.1 years with disability free while in 2007 they are expected to have 17.3 years. The improvement in self-care disability free life expectancy is found both for elderly men and women and in all ages, but the differences between 2002 and 2007 for elderly men are statistically significant for ages 60-90 while for women the improvements are statistically significant at ages 60-85 as presented in Table 6.12.

Because both total life expectancy and disability free life expectancy increased between 2002 and 2007, the health ratio or proportion of disability free life expectancy to total life expectancy was measured to indicate whether elderly live longer (total life expectancy increases) with or without self-care disability. The differences in health ratio in Table 6.12 show that the proportion of expected years free from self-care disability decreased for elderly in all ages both for men and women between 2002 and 2007. The proportion of expected years free from disability for elderly men aged 65 was reduced from 95.8 percent in 2002 to 94.0 percent in 2007. This trend was found in elderly women as the proportion of expected years free from disability of elderly aged 65 was decreased from 94.5 percent in 2002 to 91.5 percent in 2007. These declines of proportion of expected years free from disability are statistically significant.

6.7.3 Mobility Disability Free Life Expectancy (MDFLE)

Mobility disability free life expectancy is presented in Table 6.13. The results show that the disability free life expectancy based on mobility activities decreased when people get older for both men and women. The mobility disability free life expectancy for elderly women tends to be lower than men for all ages in both 2002 and 2007. In 2002, the elderly men aged 65 were expected to live free from mobility disability for 8.1 years whereas only 5.4 years of the remaining life for elderly women aged 65 was expected to be spent free from mobility disability. In 2007, the mobility disability free life expectancy for men aged 65 was 10.1 years whereas for women it was 7.6 years.

Although, elderly women tend to live longer than elderly men at the same age, disability free life expectancy based on mobility for elderly women was lower than for men. This might imply that elderly women live longer than men but with worse health in term of mobility disability. The results in Table 6.13 show that the proportions of expected years free from mobility disability in elderly men were higher than in women at all ages. In 2002, elderly men aged 65 had 51.5 percent of their life expectancy free from mobility disability compared with 31.5 percent of elderly women in the same age. Differences in proportion of expected year free from disability were also found in 2007. The elderly men aged 65 in 2007 are expected to have 59.9 percent of their life expectancy free from mobility disability while 40.1 percent of women’s total life expectancy was spent disability free.

Table 6.13: Life Expectancy, Mobility Disability Free Life Expectancy (MDFLE), Health Ratio (MDFLE/LE) and their 95% Confidence Interval by sex for Thailand 2002 and 2007

Age	LE 2002	LE 2007	Change and Direction of Change in LE	MDFLE and 95% CI 2002	MDFLE and 95% CI 2007	Change and Direction of Change in MDFLE	MDFLE/LE(%) and 95% CI 2002	MDFLE/LE(%) and 95% CI 2007	Change and Direction of Change in MDFHL/LE
Males									
60	19.4	20.2	0.8	11.6 (11.4-11.8)	13.5 (13.3-13.7)	1.9 *	59.9 (59.7-60.0)	66.9 (66.8-67.0)	7.0 *
65	15.8	16.8	0.9	8.1 (8.0-8.3)	10.1 (10.0-10.2)	1.9 *	51.5 (51.3-51.6)	59.9 (59.8-60.0)	8.5 *
70	12.6	13.7	1.1	5.1 (5.0-5.3)	6.9 (6.7-7.1)	1.8 *	41.0 (40.9-41.1)	50.7 (50.6-50.8)	9.7 *
75	9.8	10.9	1.1	3.2 (3.0-3.4)	4.5 (4.3-4.7)	1.3 *	32.4 (32.3-32.5)	41.2 (41.1-41.4)	8.8 *
80	7.4	8.5	1.1	1.7 (1.6-1.9)	2.6 (2.4-2.8)	0.9 *	23.5 (23.4-23.6)	30.6 (30.5-30.8)	7.2 *
85	5.5	6.4	0.9	0.9 (0.8-1.1)	1.4 (1.2-1.7)	0.5 *	17.1 (16.9-17.3)	22.3 (22.1-22.5)	5.2 *
90	4.0	4.7	0.7	0.6 (0.4-0.9)	0.7 (0.4-0.9)	0.1	15.3 (15.1-15.5)	14.0 (13.8-14.3)	-1.3 *
95	2.9	3.4	0.5	0.5 (0.2-0.9)	0.6 (0.3-0.9)	0.1	18.8 (18.4-19.1)	17.8 (17.5-18.1)	-1.0 *
Females									
60	21.1	22.8	1.7	8.3 (8.2-8.5)	11.0 (10.8-11.1)	2.7 *	39.5 (39.4-39.7)	48.2 (48.1-48.3)	8.6 *
65	17.1	18.9	1.9	5.4 (5.2-5.5)	7.6 (7.4-7.7)	2.2 *	31.5 (31.5-31.6)	40.1 (40.0-40.2)	8.6 *
70	13.3	15.3	2.0	3.1 (3.0-3.2)	4.7 (4.6-4.9)	1.6 *	23.3 (23.2-23.4)	30.7 (30.6-30.8)	7.4 *
75	10.2	12.0	1.8	1.8 (1.7-2.0)	2.8 (2.7-3.0)	1.0 *	17.9 (17.8-17.9)	23.4 (23.4-23.5)	5.6 *
80	7.6	9.2	1.6	1.1 (0.9-1.2)	1.4 (1.2-1.5)	0.3 *	13.9 (13.8-14.0)	14.9 (14.8-15.0)	1.0 *
85	5.5	6.8	1.3	0.5 (0.4-0.6)	0.7 (0.6-0.8)	0.2	8.9 (8.8-9.0)	9.9 (9.8-10.0)	1.0 *
90	4.0	4.9	1.0	0.3 (0.1-0.4)	0.3 (0.2-0.5)	0.1	6.6 (6.5-6.7)	6.6 (6.4-6.7)	-0.1
95	2.8	3.5	0.7	0.2 (0.1-0.3)	0.2 (0.1-0.4)	0.0	6.7 (6.6-6.9)	6.2 (6.0-6.4)	-0.5 *

Source: Author's calculations
Note: * = Statistically significant of change between 2002 and 2007 at 5% level.

The results in Table 6.13 show that the mobility disability free life expectancy improved both for men and women in all ages between 2002 and 2007. Elderly men aged 65 in 2002 could expect to live free from disability 8.1 years while in 2007 the elderly men in this age are expected to spend 10.1 years free from disability. There is an improvement of 1.9 in disability free life between 2002 and 2007. The increase of disability free life expectancy is reported for elderly women as well. The elderly women aged 65 in 2002 are expected to live another 5.4 years with disability free while in 2007 the expected years lived free from disability increased to 7.6 years. The improvement in mobility disability free life expectancy is found both for elderly men and women and at all ages. The differences between 2002 and 2007 for elderly men are statistically significant for ages 60-85 while for women the improvements are statistically significant at ages 60-80 as presented in Table 6.13.

Because total life expectancy and disability free life expectancy increased between 2002 and 2007, the health ratio or proportion of mobility disability free life expectancy to total life expectancy was measured to indicate trends in the proportion of expected years free from mobility disability. The differences in health ratio in Table 6.13 show that the proportion of expected life free from disability increased for elderly ages 60-89 both for men and women between 2002 and 2007. The proportion of expected life free from disability for elderly men aged 65 increased from 51.5 percent in 2002 to 59.9 percent in 2007. This trend was found in elderly women as the proportion of expected life free from disability for elderly aged 65 decreased from 31.5 percent in 2002 to 40.1 percent in 2007. These improvements of proportion of expected years free from disability are statistically significant.

Results of changes between 2002 and 2007 on the total life expectancy, expected life in various health states and health ratio are summarised in Table 6.14.

Table 6.14: Change in life expectancy (LE), self-rated healthy life expectancy (SRHLE), self-rated unhealthy life expectancy (SRUHLE), self-care disability free life expectancy (SCDFRLE), self-care disability life expectancy (SCDLE), mobility disability free life expectancy (MDFLE), mobility disability life expectancy (MDLE) and their health ratio by sex for Thailand 2002 and 2007

Age	Change Between 2002 and 2007 and Direction of Change												
	LE (years)	SRHLE (years)	*SRUHLE (years)*	MDFLE (years)	*MDLE (years)*	SCDFLE(years)	*SCDLE (years)*	SRHLE/ LE (%)	*SRUHLE/ LE (%)*	MDFLE/ LE (%)	*MDLE/ LE (%)*	SCDFLE/ LE (%)	*SCDLE/ LE (%)*
Males													
60	0.8	-0.1	***0.9***	1.9	***-1.1***	0.5	***0.3***	-2.3	***2.3***	7.0	***-7.0***	-1.5	***1.5***
65	0.9	0.1	***0.8***	1.9	***-1.0***	0.6	***0.3***	-1.8	***1.8***	8.4	***-8.4***	-1.8	***1.8***
70	1.1	0.3	***0.9***	1.8	***-0.7***	0.8	***0.3***	-1.1	***1.1***	9.7	***-9.7***	-2.2	***2.2***
75	1.1	0.2	***0.9***	1.3	***-0.2***	0.7	***0.4***	-1.4	***1.4***	8.8	***-8.8***	-3.1	***3.1***
80	1.1	0.3	***0.7***	0.9	***0.2***	0.5	***0.6***	0.4	***-0.4***	7.2	***-7.2***	-5.0	***5.0***
85	0.9	0.3	***0.6***	0.5	***0.4***	0.3	***0.6***	1.6	***-1.6***	5.2	***-5.2***	-8.0	***8.0***
90	0.7	0.3	***0.4***	0.1	***0.7***	0.1	***0.6***	3.5	***-3.5***	-1.3	***1.3***	-10.5	***10.5***
95	0.5	0.3	***0.2***	0.1	***0.4***	0.2	***0.3***	4.4	***-4.4***	-1.0	***1.0***	-6.1	***6.1***
Females													
60	1.7	0.6	***1.1***	2.7	***-0.9***	1.1	***0.6***	-0.2	***0.2***	8.7	***-8.7***	-2.5	***2.5***
65	1.9	0.5	***1.3***	2.2	***-0.3***	1.2	***0.7***	-0.5	***0.5***	8.6	***-8.6***	-3.0	***3.0***
70	2.0	0.6	***1.5***	1.6	***0.4***	1.3	***0.7***	-0.2	***0.2***	7.4	***-7.4***	-3.7	***3.7***
75	1.8	0.6	***1.2***	1.0	***0.8***	1.1	***0.7***	1.2	***-1.2***	5.5	***-5.5***	-4.8	***4.8***
80	1.6	0.6	***1.0***	0.3	***1.2***	0.8	***0.8***	2.0	***-2.0***	1.0	***-1.0***	-6.7	***6.7***
85	1.3	0.5	***0.8***	0.2	***1.1***	0.5	***0.8***	2.5	***-2.5***	1.0	***-1.0***	-8.4	***8.4***
90	1.0	0.4	***0.6***	0.1	***0.9***	0.3	***0.6***	3.4	***-3.4***	0.0	***0.0***	-8.2	***8.2***
95	0.7	0.2	***0.5***	0.0	***0.7***	-0.1	***0.8***	3.3	***-3.3***	-0.5	***0.5***	-16.6	***16.6***

Source: Author's calculations

The results indicate that life expectancy had increased both for men and women. This increasing life expectancy in elderly Thai appears to be accompanied by the rising of years in good health and poor health status. The changes of proportion of life year spent in various health status between 2002 and 2007 in Thailand was shown in Figure 6.2-6.4 to investigate whether the improvement in life expectancy of elderly Thai spent in good or poor health.

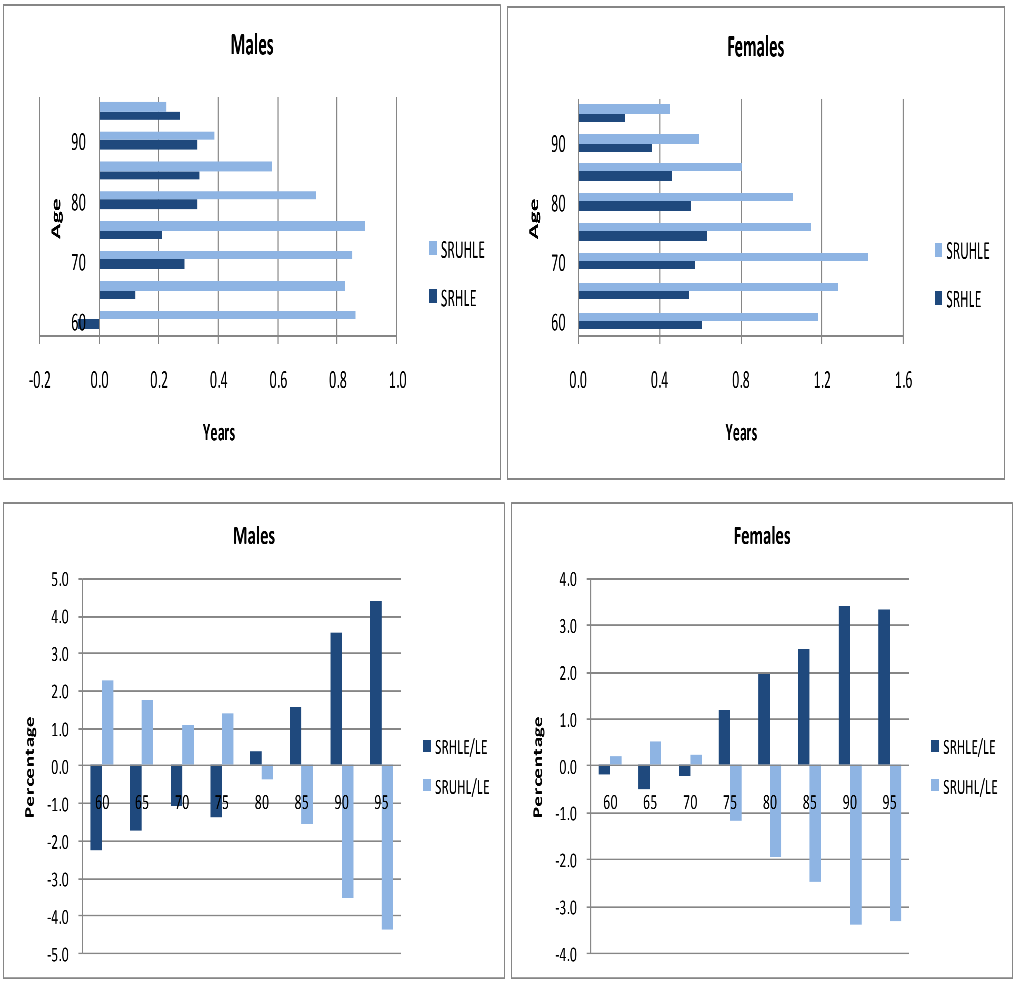


Figure 6.2: Change in self-rated healthy life expectancy (SRHLE), self-rated unhealthy life expectancy (SRUHLE), percentage of healthy life (SRHLE/LE) and percentage of unhealthy life (SRUHLE/LE) between 2002 and 2007 by gender.

Self-rated Poor Health

We can conclude the following.

a) Life years lived in poor health increased for males at all ages as shown in Figure 6.2.

b) Life years lived in poor health increased for females between 2002 and 2007 in all ages.

c) The proportion of life years lived with poor health increased for males aged 60-79 and decreased for males aged 80 and over.

d) The proportion of life lived with poor health increased for females aged 60-74 and decreased for females aged 75 and over.

Therefore,

Absolute morbidity expansion has occurred for all the old population.

Relative morbidity expansion has occurred for the younger old population.

Relative morbidity compression has occurred for the older old population.

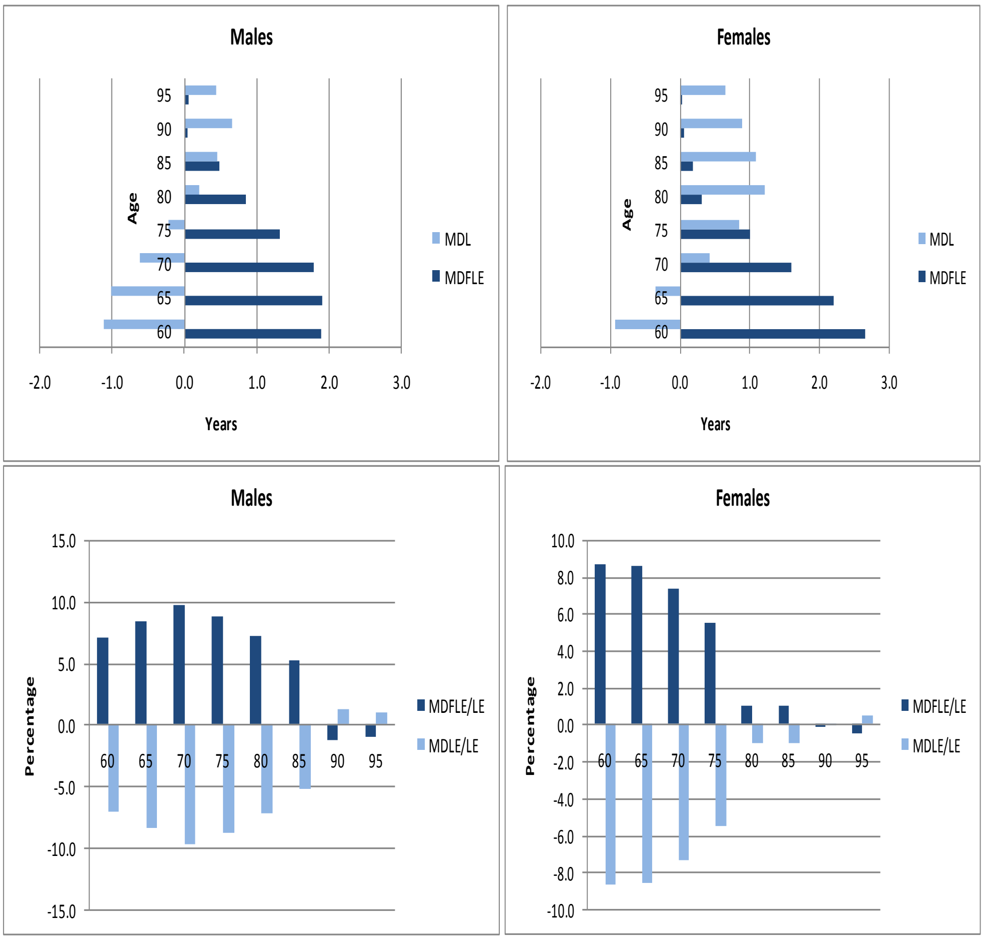


Figure 6.3: Change in mobility disability free life expectancy (MDFLE), mobility disability life expectancy (MDLE), percentage of life lived free from mobility disability (MDFLE/LE) and percentage of life lived with mobility disability (MDFLE/LE) between 2002 and 2007 by gender.

Mobility disability

Trends of change in mobility disability between 2002 and 2007 as shown in Figure 6.3 indicate the following.

a) Life years lived in mobility disability decreased for males aged 60-79 and increased for males aged 80 and over.
b) Life years lived in mobility disability decreased for females aged 60-69 whereas it increased for females aged 70 and over.
c) The proportion of life years lived with mobility disability decreased for males aged 60-89 and increased for males aged 90 and over.
d) The proportion of life lived with mobility disability decreased for females aged 60-89 and increased for females aged 90 and over

Therefore, there is evidence that:
Absolute morbidity compression has occurred for the younger old population.
Absolute morbidity expansion has occurred for the older old population.
Relative morbidity compression has occurred for the younger old population.
Relative morbidity expansion has occurred for the older old population.

Self-care disability

Figure 6.4 show changes in health trends based on self-care activities in both absolute and relative terms.

We can conclude that:
a) Life years lived in self-care disability increased for males at all ages.
b) Life years lived in self-care disability increased for females at all ages.
c) The proportion of life years lived with self-care disability increased for males at all ages.
d) The proportion of life lived with self-care disability increased for females at all ages.

Therefore,

Absolute morbidity expansion has occurred for elderly in all ages.

Relative morbidity expansion has occurred for older old population.

Although expected life with self-care disability is still quite short (maximum at 1.8 years for women aged 80, 2007 Survey results).

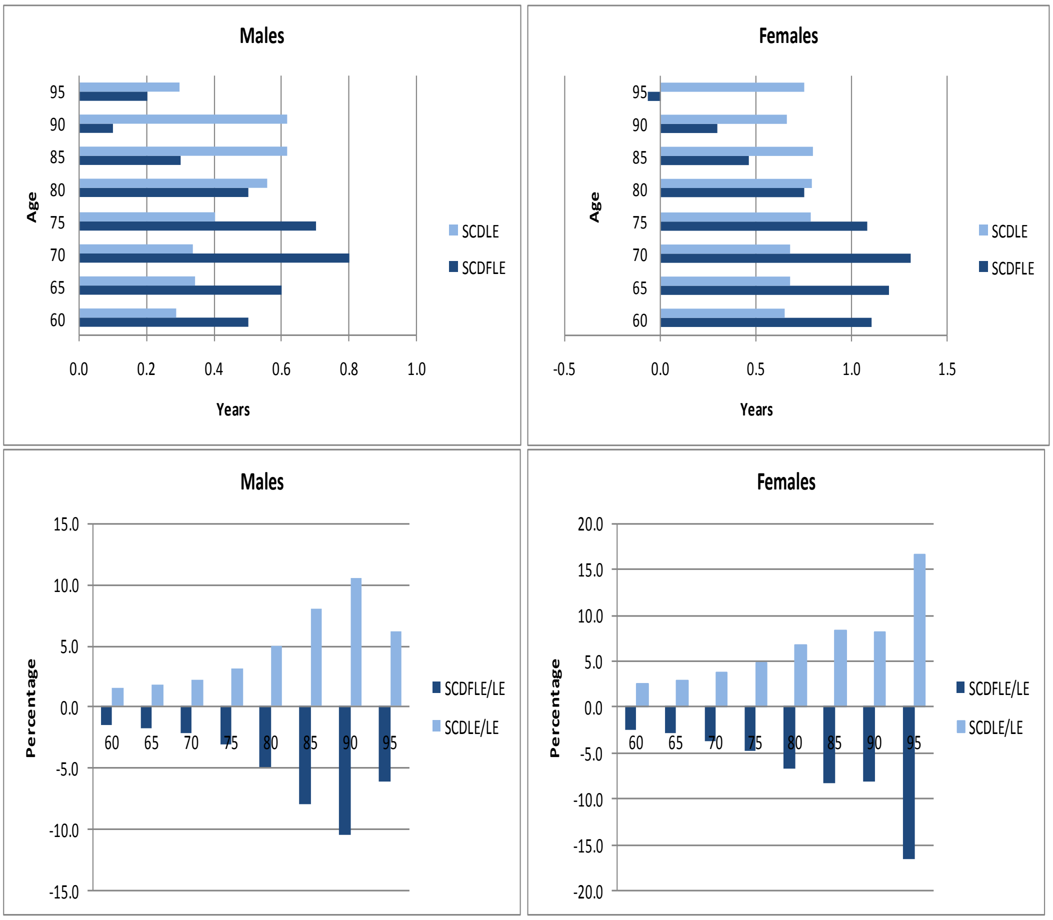


Figure 6.4: Change in self-care disability free life expectancy (SCDFLE), self-care disability life expectancy (SCDLE), percentage of life lived free from self-care disability (SCDFLE/LE) and percentage of life lived with self-care disability (SCDFLE/LE) between 2002 and 2007 by gender.

6.8 Discussion and Conclusions

This study focused on the health status of the Thai population between 2002 and 2007 and its implications for healthy life expectancy. Life expectancy for elderly

Thai who aged 60 and over increased both for men and women but, the improvements in life expectancy for women were greater than for men in all age groups. The number of years lived in good health or disability free and the number of years lived in poor health or with disability also rose at the same time, except for life lived with mobility disability. The gender differences in health in old age show that although the life expectancy of females improved more than the life expectancy of males, the increase of unhealthy life or disability life for females also higher than for males. This implies that elderly females lived longer than males but in worse health.

The results from this study show trends of health change in Thai elderly that enable us to conclude whether the morbidity compression or expansion occurred in Thailand during the 2002 to 2007 period. However, trends in health life expectancy varied by health indicators measured and ages observed as discussed in Section 6.2 (Jeune and Brønnum-Hansen 2008). Table 6.15 summaries the variations of health in old age by different health indicators.

Table 6.15: Variations of health trends in elderly by age, sex and health indicators in Thailand, 2002 and 2007.

Health indicators	**Elderly Men**		**Elderly Women**	
	Younger old	**Older old**	**Younger old**	**Older old**
Self-rated poor health	Expansion	Compression	Expansion	Compression
Mobility disability	Compression	Expansion	Compression	Expansion
Self-care disability	Expansion	Expansion	Expansion	Expansion

For self-rated health, expansion of morbidity occurred at younger old ages but not for the older old ages. Self-rated health is the health indicator that measures health in general that is linked to needs for medicine and health monitoring (Idler et al. 1999, Simpson et al. 2004) as discussed in Chapter 2. The finding that unhealthy life expanded in younger old age rather than older old age might be the result of the epidemiological transition which increased chronic diseases in Thailand (Ministry of Public Health 2008). The finding that morbidity based on self-rated health in older old population was compressed, could be a consequence of selection that only the healthier are selected to reach older old age.

However, the study of trends in healthy life expectancy between 1986 and 1995 using the Sullivan's method (Jitapunkul and Chayovan 2000) showed improvement in healthy life expectancy based on self-rated health. The comparison of the health trends between 1986 and 1995 with the health trends between 2002 and 2007 from this study is presented in Table 6.16.

The comparison shows that the improvement in life expectancy in elderly Thai was found in both men and women in both studies. The increasing life expectancy in 1986-1995 was greater than 2002-2007. This might be due to the differences in length of period of study which the first study investigated trends of change over 9 years while this study measured change over 5 years. Elderly women lived longer than men as the rise in women life expectancy was more than men but the rising of life with poor health in women was higher than men in both studies.

Table 6.16: The comparison of change in life expectancy, healthy life expectancy and health ratio for elderly Thai in periods 1986-1995 and 2002-2007

	Males					Females				
	LE	**SRHLE**	**SRUHLE**	***SRHLE/LE***	***SRUHLE/LE***	**LE**	**SRHLE**	**SRUHLE**	***SRHLE/LE***	***SRUHLE/LE***
1986-1995										
60-64	4.8	4.0	0.8	***5.4***	***-5.4***	5.3	3.2	2.1	***1.1***	***-1.1***
65-69	4.6	3.5	1.1	***4.4***	***-4.4***	5.0	3.0	2.0	***1.4***	***-1.4***
70-74	4.5	2.6	1.9	***0.5***	***-0.5***	4.9	2.8	2.1	***1.2***	***-1.2***
75-79	4.4	2.2	2.2	***-0.9***	***0.9***	5.3	3.1	2.2	***3.8***	***-3.8***
80+	5.7	3.2	2.5	***2.3***	***-2.3***	7.4	4.1	3.3	***4.8***	***-4.8***
2002-2007										
60-64	0.8	-0.1	0.9	***-2.3***	***2.3***	1.7	0.6	1.1	***-0.2***	***0.2***
65-69	0.9	0.1	0.8	***-1.8***	***1.8***	1.9	0.5	1.3	***-0.5***	***0.5***
70-74	1.1	0.3	0.9	***-1.1***	***1.1***	2.0	0.6	1.5	***-0.2***	***0.2***
75-79	1.1	0.2	0.9	***-1.4***	***1.4***	1.8	0.6	1.2	***1.2***	***-1.2***
80+	1.1	0.4	0.7	***0.5***	***-0.5***	1.6	0.6	1.0	***2.3***	***-2.3***

Sources: Jitapunkul and Chayovan (2000) for 1986-1995, author's calculations for 2002-2007
Notes: The 1986-1995 results are obtained from The Socioeconomic Consequences of the Ageing of the Population (SECAPT) in 1986 and Survey of the Welfare of Elderly in Thailand (SWET) in 1995. The 2002-2007 results are obtained from The Survey of Elderly in Thailand in 2002 and 2007.

There are the same trends in healthy life expectancy and unhealthy life expectancy between these two studies that the increases in life expectancy were accompanied by the increasing years in good and poor health. But the increase of healthy life years between 1986 and 1995 was larger than the increase of unhealthy life years. Then the proportion of life lived in poor health was reduced in the period of 1986-1995. This means morbidity was compressed in this period. A different trend was found in this study which measured change of health between 2002 and 2007. The reasons for the different trends might be due to the rapid economic growth in Thailand in the period from 1986 to 1995, which is known as the "soap-bubble" economic period (Jitapunkul and Chayovan 2000). This expansion in the economy might benefit the health of elderly Thai in the improvement of life lived with good health which was different from the 2002-2007 period when the economy in Thailand slowed down. Health trends are specific to the period when they are measured. Moreover, the study by Jitapunkul and Chayovan (2000) defined good health in a different way from this study. "Good health" was the combination of "very good", "fair" and "as usual" while "Poor health" was defined from "bad" in The Socio-economic Consequences of the Ageing of the Population Survey in Thailand (SECAPT) which conducted in 1986. "Good health" obtained from The Survey of Welfare of the Elderly in Thailand (SWET) which conducted in 1995 was the combination of the answer of "very healthy", "rather healthy" and "moderate" versus "Poor health" which combined from "rather weak" and "weak". Our study defined "Good health" as "very good" and "good" and "Poor health" was "fair", "poor" and "very poor". The differences in definition of health and wording in questionnaires might lead to the differences in health trends observed. In addition, the change in healthy life expectancy in 1986-1995 was obtained from different surveys. Small differences in questions and answers can affect conclusions the trend of health change.

The health trends based on self-care disability support the morbidity expansion hypothesis at all ages. This health indicator reflects severe disability (Michel and Robine 2004), so the expansion of self-care disability leads to the concern about long-term health care and health expenditure in later life, although the years of life lived with self-care disability were still low. The study of self-care disability in

Thailand in 1996-1997 show the same trend as found in this study although the definitions of self-care activities are different (Table 6.17).

Table 6.17: The comparison of trends in self-care disability in Thailand in 1996-97, 2002 and 2007

	Males					Females				
	LE	**SCDFLE**	**SCDLE**	***SCDFLE/ LE***	***SCDLE/ LE***	**LE**	**SCDFLE**	**SCDLE**	***SCDFLE/ LE***	***SCDLE/ LE***
1996-1997*										
60-64	20.3	18.7	1.6	***91.9***	***8.1***	23.9	21.3	2.6	***89.2***	***10.8***
65-69	17.1	15.5	1.6	***90.5***	***9.5***	20.2	17.6	2.6	***87.1***	***12.9***
70-74	14.2	12.6	1.6	***89.1***	***10.9***	16.9	14.3	2.6	***84.9***	***15.1***
75-79	11.9	10.4	1.5	***87.4***	***12.6***	14.6	12.0	2.6	***82.4***	***17.6***
80+	10.9	9.0	1.9	***82.2***	***17.8***	13.6	10.8	2.8	***79.1***	***20.9***
2002**										
60-64	19.4	18.7	0.7	***96.5***	***3.5***	21.1	20.1	1.0	***95.5***	***4.5***
65-69	15.8	15.2	0.6	***95.8***	***4.2***	17.1	16.1	1.0	***94.5***	***5.5***
70-74	12.6	11.9	0.7	***94.7***	***5.3***	13.3	12.4	0.9	***92.9***	***7.1***
75-79	9.8	9.2	0.6	***93.3***	***6.7***	10.2	9.3	0.9	***90.7***	***9.3***
80+	7.4	6.8	0.6	***91.7***	***8.3***	7.6	6.6	1.0	***87.4***	***12.6***
2007***										
60-64	20.2	19.2	1.0	***95.0***	***5.0***	22.8	21.2	1.6	***93.0***	***7.0***
65-69	16.8	15.8	1.0	***94.0***	***6.0***	18.9	17.3	1.6	***91.5***	***8.5***
70-74	13.7	12.7	1.0	***92.5***	***7.5***	15.3	13.7	1.6	***89.2***	***10.8***
75-79	10.9	9.8	1.1	***90.2***	***9.8***	12.0	10.3	1.7	***85.9***	***14.1***
80+	8.5	7.5	1.0	***88.2***	***11.8***	9.2	7.8	1.4	***84.8***	***15.2***

Sources: Jitapunkul et al. (2003) and the Author's calculations
Notes: * is the result obtained from National Health Examination Survey II, 1996-1997 (Jitapunkul et al. 2003), ** is the result obtained from The Survey of Elderly in Thailand, 2002 (Author's calculations) and *** is the result obtained from The Survey of Elderly in Thailand, 2007 (Author's calculations).

The results in Table 6.17 show that life expectancy in elderly Thai in 1996-1997 were higher than life expectancy in 2002 which obtained from this study and nearly the same as found in 2007. The decreasing of life expectancy between 1996-1997 and 2002 might due to the different sources of data on number of deaths and mid-year population used in the calculation. The life expectancy in 1996 was based on data from The Survey of Population Change in 1995-1996 whereas the life table for Thailand in 2002 and 2007 were calculated using data from Thailand Vital Registration in 2002 and 2007.

The comparison in change of self-care disability free life expectancy between 1996-1997 and 2002 and between 1996-1997 and 2007 cannot be made because the reduction of life expectancy. Moreover the self-care activities measured in 1996-

1997 were different from this study. In 1996-1997, disability means the inability to perform without assistance or requiring help from another person in 6 self-care activities of daily living (feeding, grooming, transferring, toileting, dressing and bathing).

In 2002 and 2007 disability was defined as the inability to perform without assistance or requiring help from another person in 3 self-care activities of daily living (feeding, toileting/bathing and dressing). Although the definition was different, the proportion of life lived in self-care disability and free from self-care disability can be compared. The years of life lived free from self-care disability was much higher than years of life lived with self-care disability in all three studies. More than 80 percent of life in old age is spent free from self-care disability but these percentages tend to reduce between 2002 and 2007 as discussed in Section 6.7. The comparison between genders in all studies show that elderly women were expected to live longer than men but they were expected to live with self-care disability longer than men as well.

Trends in mobility disability showed the morbidity compression in younger old age and morbidity expansion in the older old. The results confirm that the younger old age was more active in mobility than older. This health indicator reflects the abilities for using public transport or movement then the expansion of the mobility disability in older old age means the limitation in their movement increased. This suggests Thai society needs to adopt the public services such as bus, road or building so that they help the elderly in maintaining their mobility activities, particularly in older old age.

The other health indicator is self-rated health which asks the respondents to rate their general health on three or five point scales. It has become a widely used health indicator due to its ease of administration and its strength as a predictor of mortality (Idler et al. 1999). Most studies in United Kingdom and United States (Spiers et al. 1996; Zack et al. 2004) found improvement in self-rated health among the elderly whereas, the results from Sweden showed significant worsening of self–rated health in old age population between 1992 and 2002 (Parker et al. 2005).

The trends in healthy life expectancy based on self-rated health show the compression and expansion when measured in different periods of time even in the same countries and using the same question. The study in Belgium between 1997, 2001 and 2004 found the absolute expansion of life lived in poor health between 1997 and 2001 and the absolute compression between 1997 and 2004 and between 2001 and 2004. However, the relative compression occurred in all periods of time (Van Oyen et al. 2008). The self-rated unhealthy life expectancy at age 65 in Denmark between 1987 and 2005 reduced from 5.9 years to 5.0 years for males and 8.6 to 6.8 in females which lead to the improvement in percentage of good health in the same period (Jeune and Brønnum-Hansen 2008). This supported the hypothesis of compression of poor health. Moreover, health trend based on mobility was reported as mobility compression at age 65 in Denmark between 1987 and 2005 (Jeune and Bronnum-Hansen 2008).

However, trends in healthy life expectancy are dependent on health indicators chosen. The health change based on self-rated health showed the morbidity compression at age 80 between 1997 and 2004 for females in Belgium but health trends measured by disabilities in daily activities showed the morbidity expansion for the same population (Van Oyen et al. 2008). The variations in health trends can be observed when the different health indictors were applied because each health indicators measure health in different dimensions (Crimmins 2004).

Most studies have used a health indicator based on disability. Most often researchers measure disability by asking about inability to do primary activities of daily living (ADLs: e.g. ability to use toilet, bath, dress, and eat). This instrument has been used to measure health in both clinical study and community based surveys of elderly people. However, to compare the results using this indicator is often difficult due to the difference in wording and activities included. For example, some studies ask if the respondent experiences difficulty in performing the activities, whereas the others ask if the respondent needs help or is dependent. Different wordings or scales lead to differences in prevalence rates (Freedman et al. 2004). Most American studies have used ADL disability as a major outcome and the results indicated improvement or no change in ADL limitation during the 1990s, although the trend was not consistent across studies (Freedman et al. 2004; Freedman et al. 2002). A reduction in disability in old age has been reported in most developed countries based on the study by Christensen et al. (2009). The yearly change in disability affecting activities in daily living for both men and women in United States between 1977 and 1999 decreased by 2.1% and 2.4% respectively (Christensen et al. 2009).

Lafortune et al. (2007) reviewed the trends in severe disability based on the limitation in one or more activities in daily living such as eating, washing/bathing, dressing and getting in and out of bed in 12 OECD countries including Australia, Belgium, Canada, Denmark, Finland, France, Italy, Japan, the Netherlands, Sweden, the United Kingdom and the United States. The results show that there are only five of twelve countries which have a clear decline in disability among elderly people while the others show increases or stability in disability prevalence. Furthermore, in some countries the data obtained from different surveys present different trends in disability. Comparison across countries is therefore difficult because different indicators may be used in different countries. Other sources of variation which make international comparison difficult include the wording of questions and the design of studies which either include or exclude institutional populations (Parker and Thorslund 2007).

In this study the health indicators we use are based on general health and disability prevalence. As the health indicators are based on the same questions asked in both surveys, trends in population health have been evaluated. However, some caution must be exercised when interpreting trends in health expectancy estimated by Sullivan’s method, as this method is not suitable for detecting sudden changes in population health (Mathers and Robine 1997). Health prevalence data derived from cross-sectional surveys only implicitly reflect past transitions between state of health and changes in mortality rates. The period of observation (2002-2007) remains rather short compared to time series available in developed countries.

The results of this chapter show trends in life expectancy and healthy expectancy based on different health indicators as discussed above. The life expectancy for elderly Thai tend to increase between 2002 and 2007 both for elderly men and women. Elderly women tend to live longer than men at all ages and the improvements of life expectancy have been greater for elderly women than men. The increasing of life expectancy both for men and women in younger old age was accompanied by the increasing of expected years with poor health reflects the morbidity expansion whereas the older old ages experienced the poor health compression. The increase of life expectancy both for men and women in younger old age was accompanied by the compression of mobility but the trend was different for older old age, while trends based on self-care disability both for younger and older old age were accompanied by the expansion of self-care disability. The results confirm that the expected years in good health varied depending on the health indicators applied.

The next chapter will explore and investigate the population projections for Thailand from different sources to understand the impacts of population assumptions. The number of future elderly Thai also be projected using the different health assumptions to project the future population in different health states.

CHAPTER 7
PROJECTIONS OF THE POPULATION OF THAILAND AND ITS HEALTH STATUS

7.1 Introduction

Future trends in elderly population size, age-sex structure and their health status are of interest to research analysts, policy makers, planners and government. This chapter aims to estimate and project the size, proportion and change in age-sex composition of the elderly population in Thailand from 2000 to 2050. The population projection also takes into account the health status of old age Thai, which was analysed in Chapter 6, in order to forecast the size of the elderly population in different health status. To achieve this aim, this chapter will be divided into seven sections. The following Section, 7.2, provides the background of population projections, their methods and also reviews disability projections. Section 7.3 describes the cohort component method and provides steps for calculating cohort component projections. Section 7.4 reviews the population projections for Thailand 2000-2025 made by the National Economic and Social Development Board (NESDB) and the projections for 2005-2050 made by the UN Population Division in terms of the projection methods, mortality, fertility and migration assumptions. Then we compare the results of these projections. In Section 7.5, we develop a new set of fertility, mortality and migration assumptions and produce a new set of population projections for Thailand. Section 7.6 presents the projected disability prevalence rates for Thailand based on limitation in Activities in Daily Living (ADLs) and combines disability prevalence rates with the projected elderly population from Section 7.5 to project the disabled elderly population. The projection starts by assuming constant disability rates for the future. Then two variant assumptions are applied: the first increases disability prevalence rate by 2 percent for every five years and the second decreases disability prevalence rate by 2 percent for every five years to measure impacts of potential changes in disability. Section 7.7 provides a discussion of the results and summarises key findings.

7.2 Background of Population and Disability Projections

7.2.1 Population Projections

Although there are many sources of population data such as the census, vital registration or surveys, demographers are frequently called on to produce population information when census or related data are not available. Information about the present or past population is called an estimate while information about the future population is a projection or a forecast (Shaw 2007).

A projection may be defined as a numerical outcome of a particular set of assumptions about the future population (Rowland 2003). It is a conditional calculation showing what the future population would be if a particular set of assumptions were to hold true. A forecast is defined as the projection that is selected by the author(s) as the one most likely to provide an accurate prediction of the population. All forecasts are projections, but not all projections are forecasts.

Population projections can increase our understanding of the determinants of population change because they are presented in a formal quantitative model. A projection also enables us to assess the secondary effects of particular changes of a determinant in the future. Projections can play a role in decision making. A projection based on past trends and relationships raises our understanding of the dynamics of population growth and often serves as a forecast of population change that is sufficiently accurate to support good decision making. Because we cannot see precisely into the future, it is helpful to use the population projections to provide information on possible futures. Sometimes, population projections refer to the total population, but often they include information on age, sex, and other characteristics as well. For instant, national population projections can be used to plan for social security, to determine need for welfare expenditure, to forecast health status of the future population and to forecast the future cost of health care. Because of these important roles, projections are a crucial part of demographic analysis.

The population projection methods can be divided into three broad types (Booth 2006). First, **trend extrapolation** is based on the continuation of observable historical trends, so that the future values of a variable are determined by it historical values. Second, **the cohort component method** divides the population into age-sex groups or birth cohorts and accounts for the fertility, mortality and migration behaviour of each cohort. A variety of techniques can be used to project each of the three components of population growth. The third type, **structural models**, relies on observed relationships between demographic and other variables such as employment, and, if projections of the determinant variables are available, uses these variables to project population.

7.2.2 Projections of disability

As discussed in the previous chapter, healthy life expectancy is an indicator that estimates the average time that a person could expect to live in good health or without disability. Healthy life expectancy has become an important measure of population health at both national and international levels (Crimmins et al. 1989). The Department of Health (2008) chose disability free life expectancy (DFLE) as the key input to the health inequalities indicator for the UK and used it in the resources allocation model for NHS Primary Care Trusts in 2009-10. The interest in healthy life expectancy has grown as the impact of an increase in the proportion of elderly people which will lead to higher demands for health and social care in the future. There are a number of ageing studies which report that elderly people have achieved a longer life, but in worse health (Wilkins and Adams 1983, Crimmins et al. 1994, Rogers et al. 1990).

Bebbington (1988) has calculated expectation of life without disability using a question on limiting long standing illness from the UK General Household Survey. The methodology involved extending the approach used to calculate the life table to include limiting long standing illness. The results showed that although the trends over time indicated that expectation of life without disability was increasing, this was less than the increase in life expectancy (Bebbington 1988). Manton et al.

(1997) investigated chronic disability prevalence rates using data from the US National Long Term Care Surveys for the period 1982-1989 and revealed a declining trend in chronic disability rates amongst the elderly.

A projection of population or population characteristics such as disability is a numerical outcome of a set of assumptions regarding future change (Smith 1997). Projections of the numbers of people with disability are important for planning in order that government can direct resources and services efficiently and effectively (Wilson and Rees 2005, Siegel 2002). Where countries experience an increase in the number of elderly this has generated a great deal of interest in future levels of disability because the elderly are most at risk of disability and future population change might serve to increase the disabled population (Manton and Suzman 1993). Disability is strongly related to age, showing a very similar pattern to mortality. Disability prevalence rates tend to be lower at the younger ages and higher for the older. This relationship is important because a changing population structure gives important information on how the number of people with a disability might change. Population projections distinguish age and sex and the changes in levels of disability that result from demographic factors can be considered the most reliable part of disability projection.

Population projections provide forecasts of the changes in components of population change (births, deaths and migrations) and the changes in characteristics that are very important for demography and other related fields. There are many organizations which produce population projections. However, this study will review and attempt to emulate the projections of the Thailand population by The National Economic and Development Board (NESDB), an agency of the Thai government, and by the United Nations (UN) which produces population projections for Thailand and other countries. In order to understand, improve and produce sets of projections of population and their disability status for Thailand, the methods specified in the next section are used.

7.3 Population Projection: The Cohort Component Method

There are various ways of projecting population size. The methodologies used range from simple to complex models. However, most current projections rely on the cohort component method. A cohort means all units that experience a particular demographic event during a specific time interval. In the case of population, a cohort always has some geographic reference. A cohort usually consists of people who are identified both by the event and by time period in which it is experienced. The most frequently encountered type of cohort is a birth cohort which means persons who are born during the same period (Caselli et al. 2006).

The cohort component method involves projecting the future size of cohorts as well as the number of males and females (Preston et al. 2001). This projection method is based on the components of demographic change including births, deaths, and migrations. Then, the projected populations put components together as follows:

$$\text{Projected population} = \text{Population at start} - \text{Deaths} + \text{Births} + \text{Net Migration} \quad (7.1)$$

The projection proceeds by updating the population of each age-sex specific group according to assumptions about three components of population change: fertility, mortality and migration. To project the total population size and the number of males and females by five-year age groups, we find the number of people who survive or are expected to be alive in the future, and then add the number of births that take place and the net migration number (Rowland 2003). The size of the youngest age group is also affected by the number of births, which is calculated by applying assumed age-specific fertility rates to female cohorts in the reproductive age span (15-49). Then, we apply the sex ratio at birth to divide total births into males and females.

Steps for Calculating Cohort Component Projections

This study divides the steps for calculating the population projection based on cohort component model into six steps. The equations for each step of the model are now outlined. A list of variables and definitions used in the equations are provided in Table 7.1.

Table 7.1 List of variables and definitions used in the cohort component model

Variables	Definitions
${}_5P_x^t$	Population aged x to x+5 (at midyear t)
X	Age at last birthday
5	Age interval for the model used in this chapter
Z+	Last age group
${}_5S_x^t$	Number of survivors aged x to x+5 at time t and aged x+5 to x+10 at time t+5
${}_5s_x^t$	Survivorship probability of people aged x to x+5 at time t and aged x+5 to x+10 at time t+5
${}_5B^t$	Total births in the time interval t to t+5
${}_5f_x$	Age specific fertility rates at ages x to x+5
${}_5P_{xf}$	Number of females aged x to x+5
${}_5N_x$	Number of net migrant survivors aged x to x+5 at time t and aged x+5 to x+10 at time t+5
${}_5F_x^t$	Flow of net migration for persons aged x to x+5 at time t and aged x+5 to x+10 at time t+5
${}_5L_x$	Number of person years lived from ages x to x+5 to ages x+5 to x+10 (from a life table)
l_x	The number alive at exact age x (from a life table)

Step 1: Base Population (column B in Table 7.2)

The cohort component method requires the population from the most recent census or from the most recent population estimates as a base population.

Table 7.2 Steps in Cohort Component Model illustrated for the Thailand population in the time interval 2000 to 2005

A	A1	B	B1	C	D	E	F	G	H	I
		Population 2000 (base population)	**Initial Population 2000**	**Survivorship probability**	**Projected Survivors**	**Age Specific Fertility rate**	**Births**	**Births by sex and mother's age**	**Net Migration**	**Projected Population 2005**
MALES										
Sex Proportion at birth								**0.5143**		
Start Age	**End Age**			**e_0 = 63.7**						
Births	0-4		2557262	0.932128					1335	
0-4	5-9	2484049	2484049	0.975486	2383696				3238	2385031
5-9	10-14	2689780	2689780	0.993491	2423155				3167	2426393
10-14	15-19	2691905	2691905	0.993896	2672272				2974	2675439
15-19	20-24	2724091	2724091	0.991376	2675474			296918	3121	2678448
20-24	25-29	2724893	2724893	0.988929	2700598			727352	3126	2703719
25-29	30-34	2725315	2725315	0.986434	2694726			707499	2722	2697852
30-34	35-39	2727196	2727196	0.983178	2688343			527337	2020	2691065
35-39	40-44	2591880	2591880	0.978693	2681319			234178	1646	2683339
40-44	45-49	2306913	2306913	0.971883	2536655			54832	1187	2538301
45-49	50-54	1826991	1826991	0.960812	2242050			9146	728	2243237
50-54	55-59	1399877	1399877	0.943099	1755395				279	1756123
55-59	60-64	1116282	1116282	0.915537	1320223				-171	1320502
60-64	65-69	941852	941852	0.872899	1021997				-481	1021826
65-69	70-74	713130	713130	0.809698	822142				-792	821661
70-74	75-79	493667	493667	0.723671	577420				-582	576628
75-79	80-84	277122	277122	0.613194	357252				-309	356670
80-84	85-89	167110	167110	0.490530	169930				-186	169621
85-89	90-94	52609	52609	0.377299	81972				-86	81786
90-94	95-99	9284	9284	0.275299	19849				-28	19763
95-99	100-104	1547	1547	0.179412	2556				-6	2528
100+	105+	0	0	0.070319	278				-1	271
All ages		30665493			31827301			2557262		31850202
FEMALES										
Sex Proportion at birth								**0.4857**		
Start Age	**End Age**			**e_0 = 74**		**TFR = 1.82**				
Births	0-4		2415054	0.968011					1497	
0-4	5-9	2348707	2348707	0.992079	2337799				3158	2339296
5-9	10-14	2562555	2562555	0.998114	2330103				3237	2333261
10-14	15-19	2566164	2566164	0.998255	2557722				3296	2560959
15-19	20-24	2631705	2631705	0.997600	2561686	0.0444	577325	280407	3252	2564982
20-24	25-29	2687731	2687731	0.996801	2625389	0.1064	1414257	686905	2880	2628641
25-29	30-34	2848995	2848995	0.995786	2679133	0.0995	1375654	668155	2343	2682013
30-34	35-39	2906219	2906219	0.994207	2836989	0.0714	1025350	498012	1723	2839332
35-39	40-44	2735308	2735308	0.991551	2889383	0.0324	455333	221155	1424	2891106
40-44	45-49	2438564	2438564	0.987253	2712197	0.0083	106615	51783	995	2713621
45-49	50-54	1940797	1940797	0.980363	2407480	0.0016	17783	8637	566	2408475
50-54	55-59	1485000	1485000	0.969234	1902686				285	1903252
55-59	60-64	1208076	1208076	0.950986	1439312				3	1439597
60-64	65-69	1054183	1054183	0.920289	1148863				-137	1148866
65-69	70-74	836516	836516	0.871945	970153				-276	970016
70-74	75-79	600265	600265	0.803464	729396				-247	729120
75-79	80-84	357437	357437	0.702367	482291				-186	482044
80-84	85-89	253870	253870	0.567910	251052				-117	250866
85-89	90-94	87817	87817	0.431733	144175				-56	144058
90-94	95-99	19160	19160	0.314119	37913				-18	37857
95-99	100-104	1597	1597	0.204142	6019				-4	6001
100+	105+	0	0	0.077204	326				-1	321
All ages		31570666			33050068		4972316	2415054		33073685

Source: Author's calculations

Step 2: Survivorship Probability (column C in Table 7.2)

The survivorship probability is projected on the basis of mortality assumptions (for example, trends in life expectancy by sex). The survivorship probability assumptions are made by forecasting how those probabilities will change in the future to generate ${}_5s_x^{t+5}$, ${}_5s_x^{t+10}$, …, ${}_5s_x^{t+n}$ based on a particular model such as projected life expectancy, or the Model West Life Table (Coale et al. 1983).

The survivorship probability (${}_5s_x$) is calculated as shown in Equation 7.2

$${}_5s_x \quad = \quad {}_5L_{x+5} / {}_5L_x \qquad (7.2).$$

For a final open-ended interval, the survivorship probability is

$${}_5s_z \quad = \quad {}_5L_{z+} / ({}_5L_z + {}_5L_{z+}) \qquad (7.3)$$

where "z" is the age at the start of the last open-ended interval, and "z+" is the last age group.

In practice, we need a life table that extends one age interval beyond the last age group used in the cohort-component model or we make the simplifying assumption that the survivorship probabilities in the last plus one age group and the last are the same.

For example, assume the last age in the life table is 80 then we can derive

$${}_\infty s_{75+} \quad = \quad {}_\infty L_{80} / ({}_\infty L_{80} + {}_5L_{75}) \qquad (7.4)$$

so that the last age group in the projection is 75+ in this case or we assume, if we want to use 80+ as the last age group, that

$${}_5s_{75+} \quad = \quad {}_5s_{75} \qquad (7.5)$$

and

$$_5s_{80+} \quad = \quad _5s_{75+} \qquad (7.6).$$

This assumption should not affect the projection very much. Quite often the decrease in survivorship probabilities at the oldest ages flattens out because the oldest old population is selected for survival.

The survivorship probability from birth to age 0-4 depends on the ages used in life table. If the life table has ages 0, 1, and 5 then we will generate the variables

$_1L_0$, $_4L_1$, $_5L_5$

and the survivorship probability from birth to age 0-4 is

$$_5s_{-5} \quad = \quad (_1L_0+{}_4L_1)\,/5 \times l_0 \qquad (7.7).$$

The survivorship probability from age 0-4 to age 5-9 is

$$_5s_0 \quad = \quad {}_5L_5\,/\,(_1L_0+{}_4L_1) \qquad (7.8).$$

Step 3: Projected Survivors (column D in Table 7.2)

The number of survivors in the population in each age group is obtained by multiplying the start population of the previous age group by the relevant survivorship probability. Then the number of survivors in each age group is

$$_5S_{x+5}^{t+5} \quad = \quad {}_5P_x^t\ {}_5s_x^t \qquad (7.9)$$

where $_5S_{x+5}^{t+5}$ = survivors at time t+5, aged x+5 to x+10 of the start population aged x to x+5 at time t.

However, in last open-ended age group, the method for projecting the population is

$$_\infty S_{Z+}^{t+5} \quad = \quad {}_\infty s_{z+}^t\ {}_\infty P_{z+}^t + {}_5s_{z-1}^t\,{}_5P_{z-1}^t \qquad (7.10).$$

For example, to obtain the projected survivors aged 80+ in 2005 we need to add together the survivors of the population aged 75-79 in 2000 and the survivors of the population aged 80+ in 2000.

$${}_{\infty}S_{80+}^{2005} \quad = \quad {}_{\infty}s_{80+}^{2000}\,{}_{\infty}P_{80+}^{2000} \;+\; {}_{5}s_{75}^{2000}\,{}_{5}P_{75}^{2000} \qquad (7.11).$$

where ${}_{\infty}s_{80+}^{2000}\,{}_{\infty}P_{80+}^{2000}$ = survivors from ages 80+ to ages 85+

${}_{5}s_{75}^{2000}\,{}_{5}P_{75}^{2000}$ = survivors from ages 75-79 to ages 80-84.

Step 4: Forecasting New Births (column E, F, and G in Table 7.2)

The number of projected births is dependent on the number of females in the reproductive age groups (15-19 to 45-49) and the assumption about fertility (the total fertility rates or age specific fertility rates). New births are calculated by multiplying the average number of women at risk at giving birth by the age-specific fertility rate as showed in Equation 7.12:

$${}_{5}B_{-5}^{t} = \sum_{x=15}^{45} 5f_{x}^{t}\,\frac{5}{2}\left({}_{5}P_{xf}^{t} + {}_{5}P_{xf}^{t+5}\right) \qquad (7.12).$$

This is the estimate of births over 5 years based on the average number of women and average annual fertility rate in the five years interval.

Step 5: Net Migration (column H in Table 7.2)

Net migration, expressed in absolute numbers, is commonly used as the migration measure in projections. This is because migration can vary through time and is difficult to forecast. The total net migration is distributed across the age groups by multiplying the total net migration for the period by the proportion in each age group. Then the net migrant survivors in each age group are computed by multiplying the flow of net migrants (net total migration) by a survivorship probability that reflects their exposure to mortality after entry into a country:

$${}_{5}N_{x+5}^{t+5} = \left(\sqrt{{}_{5}s_{x}^{t}}\,\right)\left({}_{5}F_{x}^{t}\,\right) \qquad (7.13)$$

where ${}_5F_x^t$ is flow of net migrations of people aged x to x+5 at time t in the interval t to t+5 and where we use the square root of the corresponding survivorship probability to reflect their exposure to mortality in country after migration of half the interval.

Ideally, the net international migration flow should be the difference between immigration (${}_5I_x^t$) and emigration (${}_5E_x^t$)

$${}_5F_x^t \quad = \quad {}_5I_x^t \; - \; {}_5E_x^t \qquad (7.14).$$

However, the immigration and migration flow counts are not often available. Then a direct estimate of net migrant survivors is made based on survey data (immigrants) and guesstimate (emigrants) or on a residual estimate based on comparing populations in successive censuses. It would be better to use the gross migration flows into and out of a country-immigration and emigration, because there are subject to different determinants and age-sex profiles. However, for many countries variables referring to inflow and outflow status are absent and demographers instead use net migration estimates obtained using the residual methods.

Step 6: Projected Population (column I in Table 7.2)

The cohort component population projection model divides the population into age-sex groups and accounts separately for the fertility, mortality and migration in a particular time interval. Then population at time t+5 equals population at time t survived to time t+5 plus net migration. The final population in each age group is projected as

$${}_5P_{x+5}^{t+5} \quad = \quad {}_5S_{x+5}^{t+5} \; + {}_5N_{x+5}^{t+5} \qquad (7.15)$$

or

$${}_5P_{x+5}^{t+5} \quad = \quad {}_5s_x^t \; {}_5P_x^t \; + \left(\sqrt{{}_5S_x^t}\right) {}_5F_x^t \qquad (7.16).$$

However, in last open-ended age group the projected population is obtained as

$$ {}_{\infty}P_{z+}^{t+5} = ({}_{5}s_{z+}^{t}\ {}_{\infty}P_{z+}^{t}) + (\sqrt{{}_{5}S_{z+}^{t}})\ {}_{5}F_{z+}^{t} + ({}_{5}s_{z-1}^{t}\ {}_{5}P_{z-1}^{t}) + (\sqrt{{}_{5}S_{z-1}^{t}})\ {}_{5}F_{z-1}^{t} \qquad (7.17). $$

The first population at ages 0 to 4 at time t+5 equals infant survival probability times projected number of births in time interval t to t+5 plus the infant survival probability for net migrants times the projected number of net migrants:

$$ {}_{5}P_{0}^{t+5} = ({}_{5}s_{-5}^{t}\ {}_{5}B_{-5}^{t}) + (\sqrt{{}_{5}S_{-5}^{t}})\ {}_{5}F_{-5}^{t} \qquad (7.18). $$

7.4 Current Population Projections for Thailand

7.4.1. Thailand Population Projection 2000-2025 by the National Economic and Social Development Board (NESDB)

As the cohort component methods have been presented in a set of equations, this section now discusses how this model has been used by The National Economic and Social Development Board (NESDB). A population projection for Thailand for the year 2000-2025 has been conducted by the NESDB. The base year for the population projection is 2000, and the projection period is 25 years, to 2025. The cohort-component method was used for projecting population for Thailand 2000-2025 (NESDB 2003). The cohort-component method incorporates the effects of change in cohort size into projections. This is because changes in population members at each age depend on the size of cohorts moving through the age structure. The cohort component method is widely used to project populations by age and sex and involves calculating the future size of cohorts, taking into account the effects of fertility, mortality and migration. These projections have been implemented with five-year age groups in five years steps. This projection is based on census population 2000 (1^{st} April 2000) and the mid-year population is estimated for 1^{st} July 2000 as shown in Table 7.3.

Table 7.3: The mid-year population in 2000 (base population)

Age group	Number		
	Male	**Female**	**Total**
0-4	2,484,049	2,348,707	4,832,756
5-9	2,689,780	2,562,555	5,252,335
10-14	2,691,905	2,566,164	5,258,069
15-19	2,724,091	2,631,705	5,355,796
20-24	2,724,893	2,687,731	5,412,624
25-29	2,725,315	2,848,995	5,574,310
30-34	2,727,196	2,906,219	5,633,415
35-39	2,591,880	2,735,308	5,327,188
40-44	2,306,913	2,438,564	4,745,477
45-49	1,826,991	1,940,797	3,767,788
50-54	1,399,877	1,485,000	2,884,877
55-59	1,116,282	1,208,076	2,324,358
60-64	941,852	1,054,183	1,996,035
65-69	713,130	836,516	1,549,646
70-74	493,667	600,265	1,093,932
75-79	277,122	357,437	634,559
80+	230,550	362,444	592,994
Total	**30,665,493**	**31,570,666**	**62,236,159**

Source: NESDB (2003)

To project population to 2025, NESDB has applied assumptions regarding future trends in fertility, mortality, and migration. Three sets of population projections have been undertaken at the national level: low fertility, medium fertility and high fertility assumptions using the same mortality and migration assumptions. The total fertility rate in Thailand continues to decline. In 1990 it was estimated from census data as 2.28 children per woman. In 2000 the TFR was estimated as 1.82, a decrease of 20 percent (Table 7.4). This decline was associated with a continuing decrease in marriage rates among young women. As a result, NESDB assume in their medium forecast that TFR declines further from 1.81 in the base year to 1.71 in 2025 (Table 7.5).

Under the high fertility variant, fertility is set to 2.05 to maintain replacement level which is one of the aims for National Social and Development plan. However, the concept of replacement fertility is the level of fertility required to ensure a population replace itself in size. The two children will replace all mothers and fathers, but only if the same number of boys and girls are born and all female children survive to the end of reproductive age. Then the level of 2.1 children is an average across all women (Smallwood and Chamberlain 2005). Under the low fertility variant, TFR is set to 0.4 children below the fertility in the medium variant then, the TFR is assumed to 1.3 in 2025 (NESDB 2003).

Table 7.4: Total Fertility Rate (TFR), Thailand Census 1990 and 2000

Year of Census	**TFR**
1990	2.28
2000	1.82

Source: NSO (1990 and 2000)

Table 7.5: Fertility assumption (medium variant) at national level, Thailand, 2000-based projection

Age group	**Age Specific Fertility Rate (ASFR)**				
	2000-2005	**2005-2010**	**2010-2015**	**2015-2020**	**2020-2025**
15-19	0.0119	0.0116	0.0114	0.0111	0.0109
20-24	0.0782	0.0771	0.0760	0.0749	0.0738
25-29	0.1396	0.1377	0.1359	0.1340	0.1322
30-34	0.0879	0.0869	0.0859	0.0849	0.0839
35-39	0.0346	0.0341	0.0337	0.0332	0.0328
40-44	0.0091	0.0089	0.0087	0.0085	0.0083
45-49	0.0012	0.0011	0.0011	0.0010	0.0010
TFR	**1.81**	**1.79**	**1.76**	**1.74**	**1.71**

Source: NESDB (2003)

Mortality assumptions in this projection are based on trends in life expectancy at birth which is calculated from number of deaths and mid-year population by age group obtained from the vital registration system from 1990 to 2000. The projected life expectancies for 2005 to 2025 are extrapolated based on trends in life expectancy at birth from 1990 to 2000 (Table 7.6). The survivorship probabilities are then calculated from the Model West Life Table as presented in Table 7.7. Regional

Model Life Tables have been developed for use in situations where information on deaths is poor. Developed by Coale and Demeny (1966) and Coale et al. (1983), they provide families of life tables (West, East, North and South), set by life expectancy level, which can be used by countries without variable mortality data. The Model West Life Table has been applied because the survivorship probabilities from the Thailand life table have been found to be unreliable especially in the young and old age group in life table. Moreover, the survivorship probabilities in the middle age groups obtained from the Thailand life table are as same as from Model West Life Table. Table 7.7 shows that the mortality probability of males in age group birth to 0-1 (1-0.96288= 0.03712) is twice that of females (1-0.98278= 0.01722). In these projections, international migration is assumed to be negligible and to contribute nothing to the projected size and structure of the population.

Table 7.6: Mortality assumptions at national level, Thailand, 2000-based projection

	Life Expectancy at Birth (e_0)				
	2000-2005	**2005-2010**	**2010-2015**	**2015-2020**	**2020-2025**
Male	67.93	69.64	71.35	73.06	74.76
Female	74.90	76.24	77.58	78.92	80.26

Source: NESDB (2003)

Table 7.7: Survivorship Probabilities, Thailand, 2000-based projection

Period-Cohort		2005		2010		2015		2020		2025	
Start Age	End Age	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
birth	0-1	0.96288	0.98278	0.97054	0.98622	0.97909	0.98950	0.98833	0.99144	0.99217	0.99322
1-4	5-9	0.99438	0.99746	0.99549	0.99785	0.99648	0.99822	0.99778	0.99848	0.99853	0.99874
5-9	10-14	0.99680	0.99868	0.99736	0.99883	0.99783	0.99897	0.99846	0.99910	0.99903	0.99924
10-14	15-19	0.99567	0.99844	0.99636	0.99858	0.99692	0.99870	0.99733	0.99881	0.99781	0.99894
15-19	20-24	0.99329	0.99760	0.99411	0.99781	0.99478	0.99798	0.99538	0.99821	0.99548	0.99844
20-24	25-29	0.99212	0.99691	0.99303	0.99725	0.99377	0.99755	0.99445	0.99780	0.99483	0.99804
25-29	30-34	0.99154	0.99612	0.99268	0.99660	0.99354	0.99702	0.99415	0.99728	0.99457	0.99755
30-34	35-39	0.98972	0.99461	0.99123	0.99520	0.99236	0.99573	0.99319	0.99621	0.99392	0.99668
35-39	40-44	0.98579	0.99200	0.98793	0.99281	0.98948	0.99358	0.99019	0.99431	0.99129	0.99502
40-44	45-49	0.97823	0.98752	0.98123	0.98877	0.98351	0.98998	0.98449	0.99115	0.98627	0.99229
45-49	50-54	0.96543	0.98057	0.96959	0.98249	0.97283	0.98438	0.97448	0.98616	0.97739	0.98789
50-54	55-59	0.94522	0.97034	0.95086	0.97333	0.95569	0.97628	0.95896	0.97901	0.96411	0.98167
55-59	60-64	0.91469	0.95349	0.92221	0.95829	0.92932	0.96306	0.93574	0.96751	0.94439	0.97187
60-64	65-69	0.86930	0.92409	0.88010	0.93214	0.89065	0.94016	0.89913	0.94771	0.91269	0.95513
65-69	70-74	0.80165	0.87149	0.81589	0.88482	0.83029	0.89825	0.84219	0.91118	0.86225	0.92388
70-74	75-79	0.69874	0.78000	0.71579	0.80019	0.73364	0.82077	0.74958	0.84100	0.77548	0.86093
75-79	80-84	0.56643	0.65032	0.58281	0.67627	0.60258	0.70306	0.62584	0.72988	0.65510	0.75640
80+	85+	0.35059	0.40302	0.35795	0.42274	0.37138	0.44340	0.39767	0.46372	0.41957	0.48366
e_0		67.93	74.90	69.64	76.24	71.35	77.58	73.06	78.92	74.76	80.26

Source: NESDB (2003)

The results from the population projection 2000-2025, medium variant assumption, (Tables 7.8, 7.9, and 7.10) as computed by NESDB, show that the population will increase slowly from 62 million in 2000 to 72 million in 2025. The population growth rates decrease from 0.8 percent per annum in 2005 to 0.4 percent in 2025. The age-sex structures of the projected population show that the population share of the young age group will fall whilst the share of the elderly will rise. The increase in the population share of the aged population is due to higher survival rates and the fertility decline (UNFPA 2006a). The changing age structure leads to an increase in the total dependency ratio which is the number children, youth and aged persons per hundred people of working age. The total dependency ratio increases from 44 in 2000 to 46 in 2025. However, if this indicator is separated into young and old age group, opposing trends appear. The young dependency ratio (0-14 years) declines from 35 in 2000 to 26 in 2025, but the aged dependency ratio (65+ and over) which is the number of aged people per hundred of working age rises from 9 to 20. The population of Thailand is therefore ageing.

Table 7.8: Male population projection-medium variant (thousands)

Age Group	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**
0-4	2484	2460	2374	2300	2233	2140
5-9	2690	2466	2446	2364	2295	2229
10-14	2692	2679	2457	2439	2360	2292
15-19	2724	2680	2668	2448	2432	2354
20-24	2725	2706	2664	2653	2436	2421
25-29	2725	2700	2685	2645	2637	2422
30-34	2727	2679	2672	2662	2625	2619
35-39	2592	2649	2633	2641	2636	2604
40-44	2307	2508	2577	2586	2605	2607
45-49	1827	2231	2424	2505	2533	2563
50-54	1400	1752	2142	2334	2428	2470
55-59	1116	1318	1657	2035	2229	2336
60-64	942	1019	1212	1534	1900	2103
65-69	713	818	895	1075	1378	1732
70-74	494	571	666	742	905	1187
75-79	277	345	408	488	556	701
80+	231	238	286	352	445	550
Total	**30666**	**31819**	**32866**	**33803**	**34633**	**35330**

Source: NESDB (2003)

Table 7.9: Female Population projection-medium variant (thousands), Thailand 2000 based projection.

Age Group	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**
0-4	2349	2367	2275	2193	2113	2021
5-9	2563	2339	2359	2269	2188	2109
10-14	2566	2557	2334	2355	2266	2186
15-19	2632	2562	2552	2329	2351	2263
20-24	2688	2625	2556	2546	2324	2347
25-29	2849	2669	2612	2547	2539	2319
30-34	2906	2813	2644	2597	2536	2531
35-39	2735	2867	2776	2618	2580	2524
40-44	2439	2701	2827	2738	2592	2562
45-49	1941	2403	2660	2784	2703	2566
50-54	1485	1901	2357	2611	2739	2665
55-59	1208	1440	1849	2298	2553	2686
60-64	1054	1152	1380	1779	2222	2481
65-69	837	974	1073	1297	1686	2122
70-74	600	729	862	964	1181	1557
75-79	357	468	583	707	811	1017
80+	362	379	477	621	804	1002
Total	**31571**	**32946**	**34176**	**35253**	**36188**	**36958**

Source: NESDB (2003)

Table 7.10: Key population indicators calculated from the population projection 2000-2025, Thailand 2000-based projection.

Indicators	2000	2005	2010	2015	2020	2025
Number of Population (thousand)						
Total	62237	64765	67042	69056	70821	72288
Male	30666	31819	32866	33803	34633	35330
Female	31571	32946	34176	35253	36188	36958
Number by age group (thousand)						
Children (0-14)	15344	14868	14245	13920	13455	12977
Working (15-64)	43022	45375	47547	48890	49600	49443
Elderly (65+)	3871	4522	5250	6246	7766	9868
Population Proportion (%)						
Children (0-14)	24.65	22.96	21.25	20.16	19.00	17.95
Working (15-64)	69.13	70.06	70.92	70.80	70.04	68.40
Elderly (65+)	6.22	6.98	7.83	9.04	10.97	13.65
Dependency ratio						
Total	44.66	42.73	41.00	41.25	42.78	46.20
Child (0-14)	35.67	32.77	29.96	28.47	27.13	26.25
Aged (65+)	9.00	9.97	11.04	12.78	15.66	19.96
Growth rate (%)		0.81	0.70	0.60	0.51	0.41

Source: Author’s calculations from NESDB (2003) population projection output

7.4.2 Population Projections for Thailand 2005-2050 by the United Nations

The United Nations is one of the organizations that produce national population estimates and projections (Rowland 2003). The most recent estimates and projections are reported in the World Population Prospects, the 2006 Revision[3] (United Nations 2006b) which used population estimates for mid-year 2005 as the starting population base for the projections. The period of projection is 45 years, until 2050. The UN has employed the cohort-component method for individual country projections (United Nations 2006b). The 2006 revision has produced eight projection variants and three AIDS scenarios. The eight variants includes: low, medium, high, constant-fertility, instant-replacement fertility, constant mortality, no change (constant fertility and constant mortality), and zero migration. Moreover, the 2006 revision also produce three AIDS scenarios are: No-AIDS, high AIDS and AIDS vaccine. All of these are variations of the medium variant and the others in terms of the path mortality regarding the course of the HIV/AIDS epidemics. So, the 2006 Revision includes eleven different projection variants or scenarios as shown in Table 7.11.

The Medium-fertility assumption assumes that total fertility converges eventually toward a level of 1.85 children per woman. However, projection procedures differ slightly depending on whether a country had a total fertility above or below 1.85 children per woman in 2000-2005. Fertility in high-fertility countries (countries that until 2005 had no fertility reduction or only an incipient decline) and medium-fertility countries (countries where fertility has been declining but whose level was still above 2.1 children per woman in 2000-2005) it is assumed that, if the total fertility projected by a model of fertility decline falls to 1.85 children per woman before 2050, total fertility is held constant at that level for the remainder of the projection period (that is until 2050). Fertility in low–fertility countries (countries with total fertility at or below 2.1 children per woman in 2000-2005) is assumed to

[3] This chapter reviewed and analysed data based on the World Population Prospects, the 2006 Revision though the new UN population projections (the 2008 Revision) have become available since along this work. Because the analysis has done since 2007 and there are not much differences in term of methodology and results between two revisions.

remain below 2.1 children per woman during most of the projection period and reaches 1.85 children per woman by 2045-2050.

Table 7.11: Projection variants or scenarios in terms of assumptions for fertility, mortality and international migration

Projection variant or scenario	Assumptions		
	Fertility	**Mortality**	**International Migration**
Low fertility	Low	Normal*	Normal
Medium fertility	Medium	Normal*	Normal
High Fertility	High	Normal*	Normal
Constant-fertility	Constant as of 2000-2005	Normal*	Normal
Instant-replacement-fertility	Instant-replacement	Normal*	Normal
Constant-mortality	Medium	Constant as of 2000-2005	Normal
No change	Constant as of 2000-2005	Constant as of 2000-2005	Normal
Zero-migration	Medium	Normal*	Zero
No-AIDS	Medium	No-AIDS since 1980	Normal
High-AIDS	Medium	High-AIDS as of 2005	Normal
AIDS-vaccine	Medium	AIDS-vaccine as of 2010	Normal

Source: United Nations (2006b)
Notes:*Including the impact of HIV/AIDS in 62 countries

In the High-fertility assumption, fertility is projected to remain 0.5 children above the fertility in the medium variant over most of the projection period. That is, by 2045-2050, total fertility in the high variant reaches 2.35 children per woman. Under the low- fertility assumption, fertility is projected to remain 0.5 children below the fertility in the medium variant over most of the projection. Then, countries in low variant have a total fertility of 1.35 children per woman at the end of projection period. Based on constant-fertility assumption, fertility remains constant at the level estimated for 2000-2005. Under instant-replacement-fertility assumption, fertility is set to the level necessary to ensure a net reproduction rate of 1 starting in 2005-2010.

Under Normal-mortality assumption, mortality is projected on the basis of models of change of life expectancy produced by the United Nations Population Division. These models produce smaller gains the higher the life expectancy already reached. The selection of a model for each country is based on recent trends in life expectancy by sex. According to the 2006 Revision, 62 countries are considered to be highly affected by the HIV/AIDS epidemic. For these countries, the model incorporating a slow pace of mortality decline has generally been used so as to reflect a slowdown in the reduction of mortality risks not related to HIV/AIDS.

Under no-AIDS assumption, for each of 62 countries for which the impact of HIV/AIDS has been taken into account, mortality is estimated and projected by applying the mortality levels likely to be exhibited by the non-infected population to the whole population, thus excluding the direct impact of the epidemic. While, mortality in the high-AIDS assumption is projected by assuming that the parameters of the model determining the path of the HIV/AIDS epidemic remain constant at their 2005 level. Under AIDS-vaccine assumption, it refers to the ideal case in which a perfectly effective vaccine against HIV would be instantly available to everyone by 2010. Then, mortality is projected by assuming that no new HIV infections occur as of 2010 and remain at that level over the rest of the projection period. Under constant-mortality assumption, mortality is maintained constant in each country at the level estimated for 2000-2005.

Under the normal migration assumption, the future path of international migration is set on the basis of past international migration estimates and consideration of the policy stance of each country with regard to future international migration flows and then projected levels of net migration are kept constant over most of projection period. While, under the zero-migration assumption, international migration is set to zero starting in 2005-2010.

The population projections of this revision cover 45 years, from mid-year 2005 to mid-year 2050 then the population in mid-year 2005, the base year, is shown for Thailand in Table 7.12. However, in this chapter we will discuss first the medium variant of the population projection, 2006 revision. The medium variant is based on the fertility assumption that total fertility is assumed to converge toward a level of 1.85 children per woman (Table 7.13), but, not all countries reach this level during the projection period, that is by 2045-2050. Projection procedures differ slightly depending on whether a country had a total fertility above or below 1.85 children per woman in 2000-2005.

Table 7.12: The mid-year population for Thailand in 2005 (base population)

Age group	**Number**		
	Male	**Female**	**Total**
0-4	2,317,000	2,203,000	4,520,000
5-9	2,310,000	2,174,000	4,484,000
10-14	2,402,000	2,251,000	4,653,000
15-19	2,554,000	2,453,000	5,007,000
20-24	2,574,000	2,534,000	5,108,000
25-29	2,520,000	2,564,000	5,084,000
30-34	2,443,000	2,647,000	5,090,000
35-39	2,362,000	2,656,000	5,018,000
40-44	2,407,000	2,674,000	5,081,000
45-49	2,287,000	2,502,000	4,789,000
50-54	1,952,000	2,100,000	4,052,000
55-59	1,455,000	1,541,000	2,996,000
60-64	1,057,000	1,153,000	2,210,000
65-69	842,000	1,005,000	1,847,000
70-74	592,000	755,000	1,347,000
75-79	378,000	519,000	897,000
80-84	187,000	305,000	492,000
85-89	72,000	154,000	226,000
90-94	20,000	57,000	77,000
95-99	4,000	17,000	21,000
100+	1,000	3,000	4,000
Total	**30,736,000**	**32,267,000**	**63,003,000**

Source: United Nations (2006b)

Table 7.13 Fertility assumption for Thailand, United Nations 2005-based projections

Age group	2005-2010	2010-2015	2015-2020	2020-2025	2025-2030	2030-2035	2035-2040	2040-2045	2045-2050
15-19	0.0415	0.0375	0.0335	0.0294	0.0254	0.0214	0.0173	0.0133	0.0093
20-24	0.1058	0.1031	0.1004	0.0978	0.0951	0.0924	0.0897	0.0871	0.0844
25-29	0.1029	0.1049	0.1069	0.1088	0.1108	0.1128	0.1148	0.1168	0.1187
30-34	0.0752	0.0781	0.0810	0.0839	0.0868	0.0897	0.0926	0.0955	0.0984
35-39	0.0339	0.0350	0.0361	0.0371	0.0382	0.0393	0.0404	0.0415	0.0426
40-44	0.0089	0.0094	0.0099	0.0104	0.0109	0.0114	0.0119	0.0124	0.0130
45-49	0.0019	0.0021	0.0023	0.0026	0.0028	0.0030	0.0032	0.0035	0.0037
TFR	1.85	1.85	1.85	1.85	1.85	1.85	1.85	1.85	1.85

Source: United Nations (2006b)

Normal mortality assumption is projected mortality on the basis of models of change of life expectancy produced by the United Nations Population Division. The selection of model for each country is based on recent trends in life expectancy by sex. Based on the normal migration assumption, the future path of international migration is set on the basis of past international migration estimates and consideration of the policy of each country with regard to future international migration flows. The mortality assumption and the international migration assumption for Thailand are shown in Tables 7.14 and 7.15 respectively. The resulting population projection for Thailand 2005-2025 is shown in Tables 7.16 and 7.17.

Table 7.14: Mortality assumption for Thailand, United Nations 2005-based projections

Age group	2005-2010	2010-2015	2015-2020	2020-2025	2025-2030	2030-2035	2035-2040	2040-2045	2045-2050
Males	66.5	67.8	69.1	70.3	71.3	72.3	73.2	74.0	74.9
Females	75.0	75.7	76.6	77.4	78.2	79.0	79.7	80.4	81.1

Source: United Nations (2006b)

Table 7.15: International migration assumption for Thailand, United Nations 2005-based projections

	Net Migration (per year)								
	2005-10	2010-15	2015-20	2020-25	2025-30	2030-35	2035-40	2040-45	2045-50
Both sexes combined	35	20	20	20	20	20	20	20	20

Source: United Nations (2006b)
Notes: Net migration in thousands

Table 7.16: Male Population projection-medium variant, (thousands), Thailand, United Nations 2005-based projection

Age	**2005**	**2010**	**2015**	**2020**	**2025**
0-4	2317	2319	2225	2130	2048
5-9	2310	2274	2274	2182	2089
10-14	2402	2308	2270	2272	2182
15-19	2554	2417	2309	2273	2277
20-24	2574	2520	2382	2279	2246
25-29	2520	2453	2427	2298	2203
30-34	2443	2400	2362	2347	2227
35-39	2362	2398	2366	2336	2328
40-44	2407	2375	2396	2373	2350
45-49	2287	2401	2358	2387	2371
50-54	1952	2217	2330	2297	2333
55-59	1455	1831	2093	2209	2186
60-64	1057	1330	1686	1936	2052
65-69	842	924	1172	1494	1724
70-74	592	682	755	965	1239
75-79	378	431	501	559	721
80+	284	360	429	501	572
Total	30736	31640	32335	32838	33148

Source: United Nations (2006b)

The results from the population projection 2005-2025 by UN (Table 7.18) show that trends in population size and age-sex structure have the same pattern as the NESDB projection. The population increases slowly from 63 million to 68 million by 2025. In 2010, the population growth rates decrease from 0.67 percent in 2005 to 0.24 percent in 2025. The sex ratio or the number of males per 100 females is projected to be lower than 100 throughout the period 2000-2025 as in the results from NESDB. However, it is projected that in 2025 there will be 93 males per 100 females which is lower than in the projection by NESDB.

The age-sex structures of the projected population show that the population share of young age group will decline whilst the share of the elderly will increase. The changing age structure leads to an increase in the dependency ratio especially the old age dependency ratio which will increase to 22 percent by 2025, but the young dependency ratio decreases from 32 to 30.

Table 7.17: Female population projection-medium variant (thousands) Thailand, United Nations 2005-based projection

Age	**2005**	**2010**	**2015**	**2020**	**2025**
0-4	2203	2201	2121	2029	1949
5-9	2174	2140	2151	2072	1981
10-14	2251	2178	2138	2149	2071
15-19	2453	2290	2190	2151	2163
20-24	2534	2440	2269	2171	2133
25-29	2564	2448	2381	2215	2120
30-34	2647	2507	2409	2347	2186
35-39	2656	2672	2515	2420	2362
40-44	2674	2720	2694	2541	2449
45-49	2502	2688	2711	2689	2541
50-54	2100	2444	2631	2659	2641
55-59	1541	2021	2364	2552	2585
60-64	1153	1459	1928	2263	2449
65-69	1005	1053	1350	1794	2115
70-74	755	884	936	1209	1617
75-79	519	626	739	790	1029
80+	536	713	902	1100	1263
Total	32267	33484	34429	35151	35654

Source: United Nations (2006b)

Table 7.18: Key population indicators calculated from the population projection by United Nations

Indicators	**2005**	**2010**	**2015**	**2020**	**2025**
Number of Population (thousand)					
Total	63003	65124	66764	67989	68802
Male	30736	31640	32335	32838	33148
Female	32267	33484	34429	35151	35654
Number by age group (thousand)					
Children (0-14)	13657	13420	13179	12834	12320
Working (15-64)	44435	46031	46801	46743	46202
Elderly (65+)	4911	5673	6784	8412	10280
Population Proportion (%)					
Children (0-14)	21.68	20.61	19.74	18.88	17.91
Working (15-64)	70.53	70.68	70.10	68.75	67.15
Elderly (65+)	7.79	8.71	10.16	12.37	14.94
Dependency ratio					
Total	41.79	41.48	42.66	45.45	48.92
Child (0-14)	30.73	29.15	28.16	27.46	26.67
Aged (65+)	11.05	12.32	14.50	18.00	22.25
Growth rate(%)		0.67	0.50	0.37	0.24

Source: Author’s calculations from United Nations 2006 population projection output

7.5 Understanding the Thailand Population Projections of the NESDB and the United Nations

The population projections for Thailand, 2000-2025 by NESDB and 2005-2050 by United Nations are replicated here for two reasons: (1) in order to better understand the cohort-component method which has been employed to project the population of Thailand and (2) to better understand the projection assumptions for fertility, mortality and migration. Then, in this study the projections can be improved.

7.5.1 Reproducing the Population Projections of NESDB

NESDB reported that the mortality assumptions have been set on the basis of trends in life expectancy at birth from 1990 to 2000. The life tables for that period have been produced on the basis of number of death and mid-year population from the vital registration system. Then, life expectancies for 2005-2025 have been extrapolated by linear equation $e_0(y) = a + b\ e_0(0)$. After that, based on the projected life expectancies, the survival probabilities were calculated by applying the Model West Life Table (Coale et al. 1983).

In order to understand the mortality assumptions, the method used by NESDB will be followed. The method is divided into two parts. First, we calculate the age specific mortality rate by using the number of deaths and number of mid-year population from 1993 to 2000 which are adjusted for unknown deaths due to incompleteness of death registration. Then the age-specific mortality rates have been used to produce a life table of each year. According to these life tables, life expectancies at birth have been obtained as shown in Table 7.19.

Based on the set of life expectancies at birth in Table 7.19, life expectancies for 2005-2025 have been projected using a linear function with slope and intercept for males are 0.24 and -415.7 and for females are 0.07 and -80.58 respectively. The projected life expectancies for 2005 to 2025 from this model are shown in Table 7.20. When we compare this projected life expectancy with the life expectancies projected by NESDB in Table 7.6, it shows that we cannot produce exactly the same values. Moreover, trends in life expectancy in Table 7.19 which were used as the base for life expectancy projection (Table 7.20) fluctuate.

Table 7.19: Life expectancy at birth, Thailand 1993-2000

	e_0	
	Male	Female
1993	68.5	76.2
1994	70.2	78.7
1995	69.2	78.3
1996	68.9	77.9
1997	72.7	81.1
1998	72.5	79.2
1999	69.5	77.1
2000	70.0	77.5
Slope	0.243374	0.079549
Intercept	-415.708	-80.5827

Source: Author's calculations from deaths and population data from NESDB

Table 7.20: Projected life expectancy at birth, Thailand 2005-2025

	Life Expectancy at Birth (e_0)				
	2000-2005	**2005-2010**	**2010-2015**	**2015-2020**	**2020-2025**
Male	72.26	73.47	74.69	75.91	77.12
Female	78.91	79.31	79.71	80.11	80.50

Source: Author's calculations

The Table 7.20 results depart radically from the NESDB extrapolation in Table 7.6. For the moment we continue with the exercise of replicating the NESDB computations. However, the discrepancies suggest there is a good case for independently forecasting mortality and life expectancy for Thailand. Based on the projected life expectancy at birth from NESDB, the age specific mortality rates have been replicated by interpolation from the Model West Life Table as presented in Table 7.21. Then the survivorship probabilities are calculated as shown in Table 7.22.

Table 7.21: Interpolation the probability of dying q(x) by West Model Life Table (Coale et al. 1983): an example for female life expectancy in 2005-2010

Level	23	24	23.496
		$_nq_x$	
Age (x)	Level 23: e_0=75.000	Level 24: e_0=77.500	Level 23.496: e_0=76.24
	75.000	77.500	76.24
0	0.01530	0.00905	0.01220
1	0.00244	0.00104	0.00175
5	0.00129	0.00063	0.00096
10	0.00107	0.00053	0.00080
15	0.00179	0.00092	0.00136
20	0.00256	0.00135	0.00196
25	0.00325	0.00177	0.00252
30	0.00418	0.00236	0.00328
35	0.00586	0.00353	0.00470
40	0.00892	0.00583	0.00739
45	0.01467	0.01051	0.01261
50	0.02292	0.01713	0.02005
55	0.03616	0.02822	0.03222
60	0.05847	0.04680	0.05268
65	0.10107	0.08510	0.09315
70	0.17311	0.15148	0.16238
75	0.28667	0.26073	0.27380
80	0.43117	0.40074	0.41608
85	0.60972	0.57879	0.59438
90	0.79177	0.76776	0.77986
95	0.92696	0.91501	0.92103
100	1.00000	1.00000	1.00000

Source: Author's calculations

The linear interpolation of probability of dying ($_nq_x$) derived from the Model West Life Table at the particular life expectancy at birth, e_0, is as follow:

$$_nq_x^T = {_nq_x^A} + [({_nq_x^B} - {_nq_x^A}) \times \left(\frac{e_0^T - e_0^A}{e_0^B - e_0^A}\right)] \quad (7.19)$$

where

A< T < B

T = the target value of e_0

A, B = e_0 derived from the Model West Life Table

Table 7.22: Survivorship Probabilities for Thailand, 2005-2025 generated from West Model Life Table

Period-Cohort		2005		2010		2015		2020		2025	
Start age	End Age	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
birth	0-4	0.96569	0.98434	0.97247	0.98784	0.97877	0.99123	0.98407	0.99370	0.98868	0.99617
0-4	5-9	0.99178	0.99687	0.99380	0.99773	0.99558	0.99854	0.99690	0.99903	0.99798	0.99951
5-9	10-14	0.99656	0.99879	0.99728	0.99912	0.99796	0.99943	0.99851	0.99962	0.99898	0.99981
10-14	15-19	0.99562	0.99853	0.99644	0.99892	0.99723	0.99929	0.99790	0.99952	0.99849	0.99975
15-19	20-24	0.99321	0.99777	0.99445	0.99834	0.99563	0.99889	0.99665	0.99924	0.99757	0.99959
20-24	25-29	0.99204	0.99703	0.99354	0.99776	0.99496	0.99847	0.99618	0.99894	0.99725	0.99942
25-29	30-34	0.99147	0.99620	0.99312	0.99710	0.99468	0.99797	0.99601	0.99858	0.99716	0.99918
30-34	35-39	0.98966	0.99488	0.99162	0.99601	0.99348	0.99710	0.99507	0.99791	0.99647	0.99872
35-39	40-44	0.98570	0.99249	0.98818	0.99396	0.99056	0.99539	0.99268	0.99654	0.99458	0.99769
40-44	45-49	0.97807	0.98806	0.98127	0.99001	0.98442	0.99194	0.98739	0.99364	0.99017	0.99534
45-49	50-54	0.96531	0.98104	0.96947	0.98370	0.97366	0.98635	0.97783	0.98886	0.98189	0.99137
50-54	55-59	0.94493	0.97027	0.95020	0.97393	0.95561	0.97759	0.96126	0.98123	0.96694	0.98487
55-59	60-64	0.91402	0.95253	0.92072	0.95772	0.92770	0.96294	0.93526	0.96833	0.94308	0.97371
60-64	65-69	0.86826	0.92038	0.87664	0.92763	0.88547	0.93498	0.89529	0.94288	0.90567	0.95080
65-69	70-74	0.80000	0.86419	0.81004	0.87393	0.82070	0.88385	0.83286	0.89505	0.84597	0.90627
70-74	75-79	0.70264	0.77472	0.71424	0.78683	0.72666	0.79924	0.74112	0.81382	0.75697	0.82842
75-79	80-84	0.57674	0.65230	0.58935	0.66634	0.60297	0.68081	0.61915	0.69844	0.63718	0.71612
80+	85+	0.36148	0.41382	0.37066	0.42447	0.38058	0.43535	0.39257	0.44898	0.40604	0.46239
e_0		67.9	74.9	69.6	76.2	71.4	77.6	73.1	78.9	74.8	80.3

Source: Author's calculations

The calculation for an example in which the target life expectancy is 76.2 as set out in Table 7.21. So at age 0 the probability of dying is computed thus:

$$_1q_0\ (e_0 = 76.2) = 0.01530 + (0.00905-0.01530) \times [(76.2-75.0)/(77.5-75.0)$$

$$= 0.01530 + (-0.00625) \times 0.48$$

$$= 0.01220$$

However, when we compare the reproduced survivorship probabilities in Table 7.22 with the values in Table 7.7 by NESDB, there are differences that might come from the differences in interpolation using the Model West Life Table.

According to Figures 7.1 and 7.2, the UN estimated and projected life expectancies are much lower than those of NESDB, which are in turn lower than the author's estimates and projections. However, trend in life expectancy is assumed to be linear by NESDB and the author, but it is asymptotic for UN. The UN estimates and projections look to be too low, by about 3-4 years compared with the NESDB and 4-5 years compared with the author's projections. The UN estimates and projection tend to lag behind national estimates (because of time lags in collecting and processing the data).

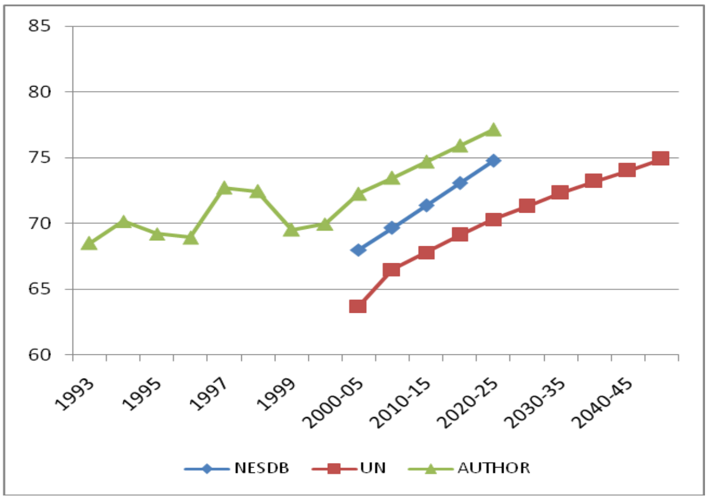


Figure 7.1: Estimated and projected life expectancy at birth (Male), Thailand 1993-2050

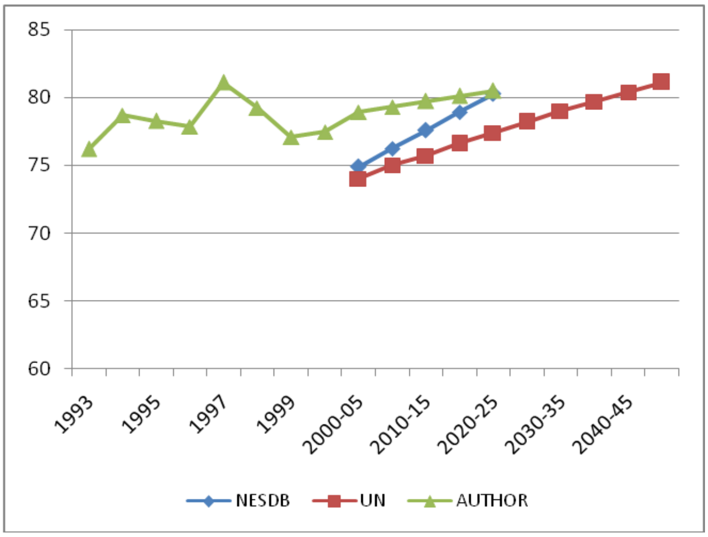


Figure 7.2: Estimated and projected life expectancy at birth (Female), Thailand 1993-2050

7.5.2 Reproducing the Population Projections of the UN

The preparation of the projections of the United Nations involves the formulation of detailed assumptions about the future paths of fertility, mortality and international migration. This section examines the assumptions and then reproduces approaches used for projecting fertility, mortality and international migration up to the year 2050.

The projection of fertility in the 2006 Revision assumed that countries in the transition from high to low fertility will approach a fertility floor of 1.85 children per woman, regardless of their current position in the fertility transition. While the assumption for countries currently below replacement level have been assumed that the fertility recovery will follow a uniform pace and reach the fertility floor at different year in the future. Because total fertility in Thailand in the 2000-2005 was above 1.85 but below 2.1, then fertility was projected to decline to 1.85 during the projection period as shown in Table 7.13. However, the projected total fertility levels were converted into age-specific fertility rates by using age patterns of fertility derived by interpolating between the most recent age pattern of fertility available and a model age-specific pattern (Table 7.13).

The projection of mortality is based on the assumptions made in terms of life expectancy at birth by sex. In the 2006 Revision, life expectancy was assumed to rise over the projection period for most countries. For countries where mortality was assumed to follow a declining trend starting in 2005, change in life expectancy was set according to a mortality improvement model (the new very fast model, the established fast, medium and slow models, and a new very slow model). All five models are based on the empirical time series of increasing life expectancy during the period 1950 to 2005. When the path of future expectation of life was determined, survival probabilities by five year age group and sex consistent with the expectation of life at birth were calculated. For countries with recent empirical information on the age patterns of mortality, survivorship probability for the projection period were obtained by extrapolating the most recent set of survivorship probability by the rate of change of an underlying model life table. Countries lacking recent information on age patterns of mortality, survivorship probability were directly obtained from an underlying model life table. There are nine model life table families from which a life table can be chosen. Four proposed by Coale and Demeny (1983) and five models for developing countries produced by the United Nations (1982).

However, The World Population Prospects, the 2006 Revision has not provided the survivorship probability for each country. In order to understand the UN method, this study attempts to reproduce the survivorship probabilities linked to the mortality assumption of the UN. Based on the projected life expectancy as shown in Table 7.14, the survivorship probability has been produced for males and females using the model life table for developing countries (General Pattern) (United Nations 1982). However, The 2006 Revision projects populations to age 100 and above, while the UN Model Life Table for Developing Countries only provides information to age 85 and above. Then to obtain the survivorship probability to age 100 and above, the UN Model Life Table for Developing Countries (general pattern) is extended.

To replicate the UN projection for Thailand required mortality probabilities for input to life tables from which we could derive the survivorship probabilities used in a cohort component projection model. To derive the mortality probabilities associated with the UN's projected life expectancy, we interpolated between the mortalities probabilities in the UN Model Life Table for Developing Countries (General Pattern), using the method already explained in connection with the replication of the NESDB projection. The results of interpolation are presented in Table 7.23 and Figure 7.3 which plots the natural logarithms of mortalities probabilities associated with a life expectancy of 66.5, against age. From age 10 mortalities probabilities show a log- linear relationship (i.e. the y follows a rising exponential pattern).

Table 7.23: Mortality probabilities, ${}_nq_x$ for males at e_0=66.5 derived from the linear interpolation using the UN Model Life Table for Developing Countries (General Pattern)

Age	${}_n\mathbf{q}_\mathbf{x}$
0	0.046125
1	0.013330
5	0.004565
10	0.003255
15	0.005130
20	0.007390
25	0.008630
30	0.010275
35	0.013925
40	0.020010
45	0.030030
50	0.046515
55	0.071535
60	0.110330
65	0.165810
70	0.241510
75	0.338400
80	0.459595
85	1.000000

Source: Author's calculations

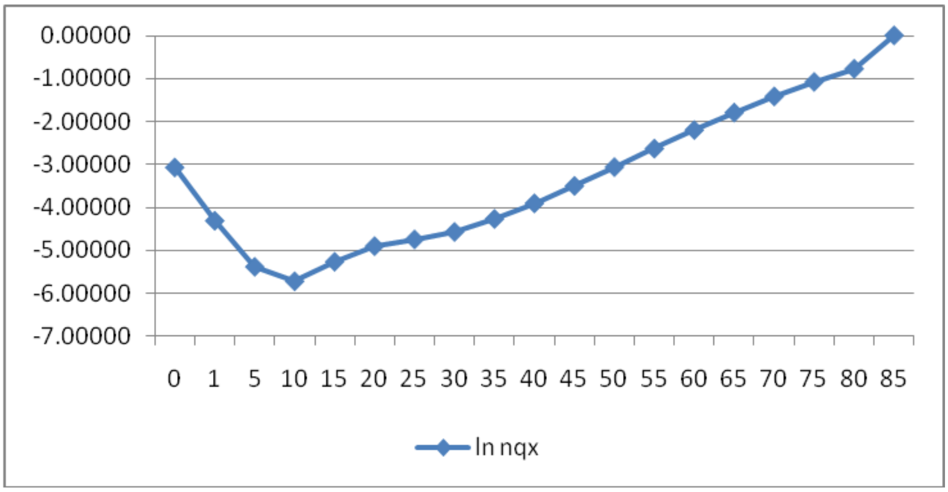


Figure 7.3: The relationship between ln ${}_nq_x$ and age

There is a difficulty. The last age in the UN Model Life Tables is 85 which is inadequate as we wish to project population up to ages 100 and over. We experimented with extrapolation of the log-linear relationship but the results in mortalities probabilities of over 1 for ages 90 and over as shown in Table 7.24. It is clear from the studies of the mortality of the very old (Vaupel 2010) that the rate of increase in mortality slows down above 90 as the upper limit of longevity is reached.

Table 7.24: Linear extrapolation of ${}_nq_x$ for males from 85 to 105 and above

Age	${}_n\mathbf{q}_\mathbf{x}$	**ln** ${}_n\mathbf{q}_\mathbf{x}$
85	0.76147	-0.27250
90	1.13480	0.12646
95	1.69116	0.52542
100	2.52029	0.92437
105	3.75592	1.32333

Source: Author's calculations

To solve this problem we adopted the following technique. We set the maximum mortality probability at 1 for age 105 and then interpolated between the mortality probabilities at age 80 and the value at age 105. The resulting probabilities are shown in the rightmost column of Table 7.25 and Figure 7.4. However, empirical studies of mortality over age 90 suggest that increases are asymptotic towards the upper limit rather than log-linear. Table 7.26 sets out a method which this asymptotic behaviour was achieved. The right most column of Table 7.26 shows the final result for mortality probabilities between 80 and 105.

Table 7.25: Adjusted ${}_nq_x$ by setting q_{105}=1 for males at e_0 = 66.5

Assumption: ln ${}_5\mathbf{q}_{\mathbf{105}}$**=0**		
Age	**ln** ${}_n\mathbf{q}_\mathbf{x}$	${}_n\mathbf{q}_\mathbf{x}$
80	-0.77741	0.45960
85	-0.62193	0.53691
90	-0.46645	0.62723
95	-0.31096	0.73274
100	-0.15548	0.85600
105	0.00000	1.00000

Source: Author's calculations

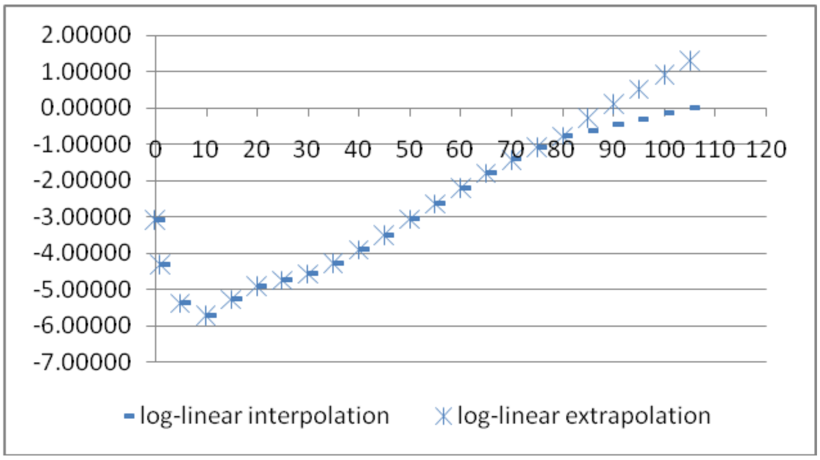


Figure 7.4: The relationship between ln ${}_nq_x$ and age by different methods for modelling ${}_nq_x$

Table 7.26: The technique of modelling ${}_nq_x$ by using power function

Give b=	0.88						
A	B	C	D	E	F	G	H
x	nqx	x	(x-80)^b	(105-80)^b	(x-80)^b/(105-80)^b	F*(q105-q80)	q80+G
80	0.45960	80	0.00000	16.98976	0.00000	0.00000	0.45960
85	0.53691	85	4.12186	16.98976	0.24261	0.13111	0.59070
90	0.62723	90	7.58578	16.98976	0.44649	0.24129	0.70088
95	0.73274	95	10.83828	16.98976	0.63793	0.34474	0.80434
100	0.85600	100	13.96067	16.98976	0.82171	0.44406	0.90365
105	1.00000	105	16.98976	16.98976	1.00000	0.54041	1.00000

Source: Author's calculations

Based on results in Table 7.26, ${}_nq_x$ for males aged 85-105 are presented in Column H. Apply the ${}_nq_x$ for ages 0-80 which obtained from Table 7.23 and ${}_nq_x$ for ages 85-105 as obtained from Table 7.26 to produce life table for males as shown in Table 7.27. The results in Table 7.27 show that the life expectancy at birth (e_0) is equal to those set in the UN mortality assumption for Thailand. These methods in modelling ${}_nq_x$ were applied for the UN mortality assumption to provide the set of survivor probabilities which were needed for population projection.

Table 7.27: Model life table for the UN projection of Thailand's population for a life expectancy of 66.5 for men with modelled mortality probabilities between 80 and 105

Age	$_nq_x$	$_np_x$	l_x	$_nd_x$	$_nL_x$	T_x	e_x
0	0.04613	0.95388	100000	4613	96771	6649969	66.5
1	0.01333	0.98667	95388	1272	379007	6553198	68.7
5	0.00457	0.99544	94116	430	469506	6174191	65.6
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
95	0.80434	0.19566	1850	1488	5530	6597	3.6
100	0.90365	0.09635	362	327	992	1067	2.9
105	1.00000	0.00000	35	35	75	75	2.2

Source: Author's calculations

A set of survivorship probabilities for males based on the mortality assumption in the UN population projection for Thailand 2005-2050 was replicated as shown in Table 7.28. For females, life expectancies at birth are 75.0, 75.7, 76.6, 77.4, 78.2, 79.0, 79.7, 80.4, and 81.1 for projection periods 2005-10, 2010-15, 2015-20, 2020-25, 2025-30, 2030-35, 2035-40, 2040-45, and 2045-50, respectively. Then to calculate survivorship probability for female using The UN Model Life Table for Developing Countries, the estimated method for mortality probabilities as applied above for males was used. The results of the series of survivorship probabilities are shown in Table 7.29.

The international migration assumption in the 2006 Revision has been set as net migration which presented the difference between the number of immigrants and the number of emigrants for particular countries and periods of time. However, given the lack of information on the age distribution of the migrant flows, this study first attempted to distribute net migration (Table 7.15) into net migration by age and sex using expert judgment (Rees, P.) and based on trends in international migration in Thailand (Huguet and Punpuing 2005) as shown in Tables 7.30 to 7.31.

Table 7.28: Survivorship probabilities for males based on the mortality assumption in the UN population projection for Thailand 2005-2050

	$_nS_x$								
e_0	**66.5**	**67.8**	**69.1**	**70.3**	**71.3**	**72.3**	**73.2**	**74.0**	**74.9**
Age									
-5	0.951556	0.956707	0.961612	0.965898	0.969307	0.972555	0.975329	0.977681	0.980167
0	0.986817	0.988694	0.990397	0.991813	0.992895	0.993884	0.994695	0.995363	0.996033
5	0.996089	0.996641	0.997140	0.997558	0.997880	0.998172	0.998415	0.998615	0.998817
10	0.995809	0.996354	0.996852	0.997278	0.997609	0.997912	0.998168	0.998380	0.998601
15	0.993743	0.994533	0.995264	0.995886	0.996374	0.996825	0.997205	0.997520	0.997849
20	0.991992	0.992987	0.993908	0.994700	0.995316	0.995889	0.996372	0.996775	0.997189
25	0.990551	0.991708	0.992786	0.993717	0.994438	0.995111	0.995676	0.996156	0.996646
30	0.987909	0.989328	0.990664	0.991821	0.992723	0.993569	0.994284	0.994892	0.995522
35	0.983054	0.984875	0.986612	0.988127	0.989327	0.990468	0.991443	0.992270	0.993142
40	0.975031	0.977417	0.979721	0.981758	0.983399	0.984977	0.986345	0.987515	0.988772
45	0.961853	0.964986	0.968055	0.970819	0.973077	0.975281	0.977218	0.978904	0.980733
50	0.941273	0.945321	0.949347	0.953042	0.956099	0.959132	0.961833	0.964210	0.966835
55	0.909787	0.914985	0.920236	0.925124	0.929222	0.933341	0.937052	0.940353	0.944059
60	0.863550	0.870286	0.877175	0.883662	0.889163	0.894743	0.899825	0.904385	0.909562
65	0.799762	0.808273	0.817060	0.825439	0.832606	0.839942	0.846686	0.852782	0.859782
70	0.716698	0.726632	0.737004	0.747010	0.755653	0.764589	0.772886	0.780452	0.789244
75	0.613344	0.623545	0.634316	0.644829	0.654001	0.663592	0.672589	0.680870	0.690616
80	0.494410	0.503828	0.514053	0.524228	0.532738	0.541850	0.550406	0.558113	0.567647
85	0.377299	0.385517	0.394812	0.404237	0.411372	0.419278	0.426619	0.432868	0.441286
90	0.275299	0.281613	0.288876	0.296301	0.301701	0.307774	0.313389	0.318046	0.324565
95	0.179412	0.183656	0.188591	0.193663	0.197252	0.201329	0.205086	0.208145	0.212542
100+	0.070319	0.071891	0.073726	0.075610	0.076912	0.078396	0.079755	0.080843	0.082433

Source: Author's calculations

The results from the replication of the NESDB population projection for Thailand 2000-2025 and the UN World Population Prospects, the 2006 Revision for Thailand are not the same as their original publications. Based on the assumptions and information available from the NESDB and the UN publications, we cannot replicate the same projections they made due to lack of details in some stages of projection methods. We had to introduce assumptions as discussed in Subsection 7.5.1 and 7.5.2 in replicating the projections which lead to the different results. Then new population projections for Thailand were developed in Section 7.6 based on the new assumptions

Table 7.29: Survivorship probabilities for females based on the mortality assumption in the UN population projection for Thailand 2005-2050

	$_nS_x$							
e_0	**75.7**	**76.6**	**77.4**	**78.2**	**79.0**	**79.7**	**80.4**	**81.1**
Age								
-5	0.972264	0.973929	0.975273	0.976581	0.977785	0.978807	0.979749	0.980683
0	0.993438	0.993831	0.994150	0.994459	0.994744	0.994986	0.995209	0.995429
5	0.998462	0.998555	0.998629	0.998702	0.998769	0.998825	0.998877	0.998929
10	0.998582	0.998667	0.998736	0.998803	0.998865	0.998917	0.998965	0.999013
15	0.998057	0.998174	0.998268	0.998360	0.998444	0.998516	0.998582	0.998647
20	0.997399	0.997555	0.997681	0.997804	0.997916	0.998012	0.998101	0.998188
25	0.996540	0.996747	0.996915	0.997078	0.997229	0.997356	0.997474	0.997590
30	0.995180	0.995469	0.995703	0.995930	0.996140	0.996317	0.996481	0.996643
35	0.992844	0.993273	0.993620	0.993957	0.994268	0.994532	0.994775	0.995015
40	0.989017	0.989675	0.990209	0.990726	0.991203	0.991608	0.991981	0.992350
45	0.982866	0.983893	0.984725	0.985532	0.986276	0.986907	0.987490	0.988065
50	0.972895	0.974518	0.975836	0.977111	0.978290	0.979287	0.980209	0.981119
55	0.956441	0.959047	0.961166	0.963215	0.965110	0.966711	0.968195	0.969655
60	0.928481	0.932753	0.936238	0.939598	0.942711	0.945339	0.947777	0.950171
65	0.884125	0.891031	0.896691	0.902126	0.907177	0.911427	0.915384	0.919253
70	0.821050	0.831673	0.840449	0.848818	0.856636	0.863181	0.869311	0.875262
75	0.726306	0.742446	0.755956	0.768697	0.780698	0.790664	0.800085	0.809126
80	0.597723	0.621172	0.641244	0.659823	0.677569	0.692110	0.706066	0.719208
85	0.466695	0.497131	0.524227	0.548527	0.572282	0.591326	0.610064	0.627167
90	0.354776	0.390266	0.423964	0.452744	0.481882	0.504507	0.527603	0.547713
95	0.252172	0.290879	0.331398	0.363771	0.398112	0.423713	0.451135	0.473526
100+	0.135973	0.172925	0.217657	0.248858	0.282878	0.306063	0.331813	0.350108

Source: Author’s calculations

7.6 A New Population Projection for Thailand

7.6.1 The Projection Assumptions

This section aims to develop a new population projection for Thailand 2000-2050 using the cohort component method. In order to improve the population projections conducted by NESDB as presented in Section 7.4, this new projection is extended to cover the population to the year 2050 as in the UN projection. The base year for this projection is 2000 when the last census for which published tables of statistics are available was conducted in Thailand. The mid-year population is obtained from the census in the same ways as the NESDB projection in Section 7.4, Table 7.3.

Table 7.30: Net migration by age for males

Age at the end	**2005-10**	**2010-15**	**2015-20**	**2020-25**	**2025-30**	**2030-35**	**2035-40**	**2040-45**	**2045-50**
0-4	420	240	240	240	240	240	240	240	240
5-9	210	120	120	120	120	120	120	120	120
10-14	210	120	120	120	120	120	120	120	120
15-19	420	240	240	240	240	240	240	240	240
20-24	2100	1200	1200	1200	1200	1200	1200	1200	1200
25-29	3150	1800	1800	1800	1800	1800	1800	1800	1800
30-34	4200	2400	2400	2400	2400	2400	2400	2400	2400
35-39	4200	2400	2400	2400	2400	2400	2400	2400	2400
40-44	4200	2400	2400	2400	2400	2400	2400	2400	2400
45-49	1050	600	600	600	600	600	600	600	600
50-54	420	240	240	240	240	240	240	240	240
55-59	210	120	120	120	120	120	120	120	120
60-64	210	120	120	120	120	120	120	120	120
65-69	0	0	0	0	0	0	0	0	0
70-74	0	0	0	0	0	0	0	0	0
75-79	0	0	0	0	0	0	0	0	0
80-84	0	0	0	0	0	0	0	0	0
85-89	0	0	0	0	0	0	0	0	0
90-94	0	0	0	0	0	0	0	0	0
95-99	0	0	0	0	0	0	0	0	0
100+	0	0	0	0	0	0	0	0	0
105+	0	0	0	0	0	0	0	0	0

Source: Author’s calculations

A new set of projection assumptions is also introduced as shown in Table 7.32. The fertility assumption is set to continue to decline but not lower than 1 based on trends of total fertility rates obtained from the census (1990 and 2000) and survey of population change (1995). Total fertility rates in 1990, 1995 and 2000 were 2.28, 2.00 and 1.82 then the extrapolation of these total fertility rates is done to estimate total fertility rates in year 2005 to 2045. The age-specific fertility rates (ASFR) are estimated for each total fertility rate using the distribution of ASFR for Thailand in the 2006 World Population Prospects as shown in Table 7.33.

Table 7.31: Net migration by age for females

Age at the end	**2005-10**	**2010-15**	**2015-20**	**2020-25**	**2025-30**	**2030-35**	**2035-40**	**2040-45**	**2045-50**
0-4	280	160	160	160	160	160	160	160	160
5-9	140	80	80	80	80	80	80	80	80
10-14	140	80	80	80	80	80	80	80	80
15-19	280	160	160	160	160	160	160	160	160
20-24	1400	800	800	800	800	800	800	800	800
25-29	2100	1200	1200	1200	1200	1200	1200	1200	1200
30-34	2800	1600	1600	1600	1600	1600	1600	1600	1600
35-39	2800	1600	1600	1600	1600	1600	1600	1600	1600
40-44	2800	1600	1600	1600	1600	1600	1600	1600	1600
45-49	700	400	400	400	400	400	400	400	400
50-54	280	160	160	160	160	160	160	160	160
55-59	140	80	80	80	80	80	80	80	80
60-64	140	80	80	80	80	80	80	80	80
65-69	0	0	0	0	0	0	0	0	0
70-74	0	0	0	0	0	0	0	0	0
75-79	0	0	0	0	0	0	0	0	0
80-84	0	0	0	0	0	0	0	0	0
85-89	0	0	0	0	0	0	0	0	0
90-94	0	0	0	0	0	0	0	0	0
95-99	0	0	0	0	0	0	0	0	0
100+	0	0	0	0	0	0	0	0	0
105+	0	0	0	0	0	0	0	0	0

Source: Author's estimates of the age-sex distribution of UN net migration assumption

Table 7.32: The new population projection assumptions for Thailand 2000-2050

Assumptions	2000-5	2005-10	2010-15	2015-20	2020-25	2025-30	2030-35	2035-40	2040-45	2045-50
Mortality: e_0										
Males	67.9	72.3	73.5	74.7	75.9	77.1	78.3	79.6	80.8	82.0
Females	74.9	78.9	79.3	79.7	80.1	80.5	80.9	81.3	81.7	82.1
Fertility: TFR	1.82	1.73	1.70	1.58	1.45	1.33	1.21	1.09	1.09	1.09
Migraton:										
Net Migration										
Males	22901	22901	22901	22901	22901	22901	22901	22901	22901	22901
Females	23617	23617	23617	23617	23617	23617	23617	23617	23617	23617

Source: Author's estimates

Table 7.33: The age specific fertility rates and total fertility rates for Thailand 2000-2050

Age group	Age Specific Fertility Rate (ASFR)									
	2000-5	2005-10	2010-15	2015-20	2020-25	2025-30	2030-35	2035-40	2040-45	2045-50
15-19	0.0444	0.0388	0.0345	0.0286	0.0231	0.0183	0.0140	0.0102	0.0078	0.0055
20-24	0.1064	0.0989	0.0947	0.0858	0.0766	0.0684	0.0604	0.0529	0.0513	0.0497
25-29	0.0995	0.0962	0.0964	0.0913	0.0853	0.0797	0.0738	0.0676	0.0688	0.0700
30-34	0.0714	0.0703	0.0718	0.0692	0.0658	0.0624	0.0587	0.0546	0.0563	0.0580
35-39	0.0324	0.0317	0.0321	0.0308	0.0291	0.0275	0.0257	0.0238	0.0244	0.0251
40-44	0.0083	0.0083	0.0086	0.0084	0.0082	0.0079	0.0075	0.0070	0.0073	0.0076
45-49	0.0016	0.0017	0.0019	0.0020	0.0020	0.0020	0.0020	0.0019	0.0020	0.0022
TFR	1.82	1.73	1.70	1.58	1.45	1.33	1.21	1.09	1.09	1.09

Source: Author’s estimates

The total fertility rates were projected to reduce during the projection period. The 2009 Reproductive Health Survey in Thailand show that the total fertility rates in Thailand continue to decrease and reached 1.3 in 2009 (NSO 2010) which is lower than the assumption as set in this projection (Table 7.33). Moreover, the new population projection for Thailand 2000-2030 by NESDB (2005) introduced a lower total fertility rates than the projection in 2003(NESDB 2003). In the population projection 2000-2025, total fertility rates were estimated to reduce from 1.8 in 2000 to reach 1.7 in 2025. Whereas in the population projection 2000-2030, NESDB estimated the lower total fertility rates to reduce from 1.8 in 2000 to reach 1.35 in 2030. Moreover, a trend of low total fertility rates was found in many countries in South East Asia and Asia such as Singapore and South Korea where the total fertility rate for 2000-2005 were lower than 1.5 (United Nations 2007a).

The mortality assumption is developed based on the extrapolation of trends of life expectancy at birth (e_0) obtained from vital registration in 1993-2000 as presented in Section 7.4, Table 7.6. Life expectancy at birth is assumed to rise from 67.9 for males and 74.9 for females in 2000-2005 to 82.0 and 82.1 in 2050 respectively as presented in Table 7.32. Life expectancy at birth for males is expected to be lower than females in the same age group but life expectancy at birth for males is projected to improve more rapidly than for females. The gender gap of life expectancy is expected to reduce in the future. The narrowing of gender gap differences was observed in Thailand in the long period. In 1964-1965, the difference in life expectancy at birth between males and females was 6.1 years and the gap reduced to 4.7 years in period 1995-2000 (Ministry of Public Health, 2008). Moreover, the main causes of death for males related to the infectious diseases and circular system whereas causes of death in females mainly are cancer, tumor and diseases of circular system which have high proportion in females (Ministry of Public Health, 2008). The reducing of deaths from infectious diseases to chronic diseases due to the epidemiological transition might lead to more benefit in males life expectancy in the future.

Based on the assumption on life expectancy at birth, the survivorship probability (s_x) for male and female are estimated from the model life table for developing countries (General Pattern). The estimation method is explained in Section 7.5.2. The set of survivorship probabilities based on life expectancy at birth are presented in Table 7.34. Migration assumption is improved from the NESDB population projection for Thailand by introducing the constant inward net migration for male and female as 22,901 and 23,617 respectively. These net migrations shown in Table 7.32 are estimated from the migration stocks for Thailand in 1990 and 2000 (United Nations 2008). The migration stocks in 1990 and 2000 are defined using different criteria. Migration is defined based on country of birth in 1990 and based on country of citizenship in 2000. Then the net migration for population projection 2000-2050 is estimated based on the countries of birth. The estimated net migration for population aged 60 and over in Thailand is expected to be emigration while the younger age group is immigration. This can be explained as the younger population particularly the working age groups migrate to Thailand for working and then when they reached the retirement aged, they returned to their countries of origin.

7.6.2 The Results of Population Projection for Thailand 2000-2050

The total population in Thailand is projected to increase from 62 million in 2000 to 73 million in 2030 while after that the total population is projected to decrease to 67 million in 2050 as presented in Table 7.35. The number of projected population based on the author's population projection for Thailand 2000-2050 is shown in Appendix B

Table 7.34: Survivorship Probabilities for Thailand, 2000-2045

Period-Cohort		**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**
Males											
Start age	End age										
birth	0-4	0.957098	0.972555	0.976211	0.979614	0.981623	0.983104	0.984459	0.985788	0.986902	0.987900
0-4	5-9	0.988835	0.993884	0.994946	0.995884	0.996342	0.996637	0.996907	0.997171	0.997393	0.997592
5-9	10-14	0.996682	0.998172	0.998490	0.998772	0.998910	0.998998	0.999078	0.999157	0.999223	0.999282
10-14	15-19	0.996395	0.997912	0.998248	0.998552	0.998708	0.998812	0.998908	0.999001	0.999079	0.999149
15-19	20-24	0.994593	0.996825	0.997323	0.997776	0.998013	0.998173	0.998320	0.998463	0.998584	0.998692
20-24	25-29	0.993062	0.995889	0.996523	0.997097	0.997402	0.997612	0.997803	0.997991	0.998148	0.998290
25-29	30-34	0.991795	0.995111	0.995856	0.996537	0.996900	0.997150	0.997378	0.997602	0.997790	0.997959
30-34	35-39	0.989435	0.993569	0.994512	0.995382	0.995858	0.996192	0.996497	0.996796	0.997048	0.997273
35-39	40-44	0.985014	0.990468	0.991753	0.992948	0.993647	0.994160	0.994628	0.995087	0.995472	0.995817
40-44	45-49	0.977599	0.984977	0.986784	0.988493	0.989582	0.990422	0.991189	0.991942	0.992574	0.993140
45-49	50-54	0.965226	0.975281	0.977850	0.980326	0.982089	0.983533	0.984852	0.986147	0.987233	0.988206
50-54	55-59	0.945632	0.959132	0.962724	0.966252	0.969116	0.971605	0.973880	0.976112	0.977985	0.979663
55-59	60-64	0.915386	0.933341	0.938290	0.943236	0.947835	0.952040	0.955881	0.959651	0.962813	0.965649
60-64	65-69	0.870808	0.894743	0.901534	0.908411	0.915592	0.922396	0.928609	0.934706	0.939821	0.944413
65-69	70-74	0.808934	0.839942	0.848971	0.858226	0.869053	0.879607	0.889239	0.898693	0.906621	0.913755
70-74	75-79	0.727406	0.764589	0.775723	0.787289	0.803070	0.818938	0.833408	0.847613	0.859522	0.870273
75-79	80-84	0.624342	0.663592	0.675694	0.688450	0.710755	0.734051	0.755267	0.776099	0.793558	0.809403
80-84	85-89	0.504524	0.541850	0.553812	0.566334	0.596336	0.628824	0.658348	0.687346	0.711635	0.733865
85-89	90-94	0.386049	0.419278	0.430289	0.441464	0.479510	0.521345	0.559231	0.596465	0.627622	0.656523
90-94	95-99	0.281999	0.307774	0.316448	0.325149	0.371675	0.422063	0.467449	0.512098	0.549408	0.584709
95-99	100-104	0.183906	0.201329	0.207248	0.213137	0.269361	0.327742	0.379905	0.431294	0.474148	0.515855
100+	105+	0.071980	0.078396	0.080567	0.082701	0.148655	0.210770	0.262476	0.310488	0.348025	0.384369
e_0		**67.9**	**72.3**	**73.5**	**74.7**	**75.9**	**77.1**	**78.3**	**79.6**	**80.8**	**82.0**
Females											
Start age	End age										
birth	0-4	0.970658	0.977634	0.978236	0.978807	0.979346	0.979884	0.980422	0.980923	0.981405	0.981887
0-4	5-9	0.993022	0.994708	0.994851	0.994986	0.995113	0.995240	0.995368	0.995486	0.995600	0.995714
5-9	10-14	0.998362	0.998760	0.998794	0.998825	0.998855	0.998885	0.998915	0.998942	0.998969	0.998996
10-14	15-19	0.998489	0.998857	0.998888	0.998917	0.998944	0.998972	0.998999	0.999025	0.999050	0.999074
15-19	20-24	0.997929	0.998433	0.998476	0.998516	0.998553	0.998591	0.998629	0.998664	0.998698	0.998731
20-24	25-29	0.997228	0.997902	0.997959	0.998012	0.998063	0.998113	0.998164	0.998211	0.998256	0.998301
25-29	30-34	0.996317	0.997210	0.997285	0.997356	0.997423	0.997490	0.997557	0.997620	0.997680	0.997740
30-34	35-39	0.994877	0.996114	0.996218	0.996317	0.996411	0.996504	0.996598	0.996685	0.996769	0.996852
35-39	40-44	0.992409	0.994229	0.994384	0.994532	0.994671	0.994810	0.994948	0.995078	0.995202	0.995327
40-44	45-49	0.988372	0.991144	0.991382	0.991608	0.991821	0.992034	0.992247	0.992446	0.992637	0.992827
45-49	50-54	0.981884	0.986184	0.986555	0.986907	0.987240	0.987573	0.987905	0.988215	0.988513	0.988810
50-54	55-59	0.971370	0.978143	0.978729	0.979287	0.979815	0.980341	0.980865	0.981355	0.981827	0.982298
55-59	60-64	0.954030	0.964874	0.965815	0.966711	0.967560	0.968406	0.969247	0.970035	0.970795	0.971551
60-64	65-69	0.924590	0.942325	0.943868	0.945339	0.946735	0.948123	0.949503	0.950798	0.952046	0.953287
65-69	70-74	0.877910	0.906551	0.909044	0.911427	0.913696	0.915944	0.918173	0.920273	0.922299	0.924309
70-74	75-79	0.811518	0.855672	0.859505	0.863181	0.866703	0.870175	0.873599	0.876848	0.879989	0.883091
75-79	80-84	0.711881	0.779230	0.785047	0.790664	0.796092	0.801401	0.806595	0.811578	0.816411	0.821149
80-84	85-89	0.576696	0.675428	0.683866	0.692110	0.700191	0.707990	0.715520	0.722880	0.730051	0.737001
85-89	90-94	0.438411	0.569482	0.580414	0.591326	0.602268	0.612589	0.622342	0.632185	0.641840	0.651018
90-94	95-99	0.318936	0.478574	0.491310	0.504507	0.518168	0.530607	0.541982	0.554068	0.566017	0.577047
95-99	100-104	0.207232	0.394424	0.408351	0.423713	0.440228	0.454526	0.467027	0.481368	0.495635	0.508280
100+	105+	0.080107	0.279647	0.291403	0.306063	0.322184	0.334660	0.344601	0.357615	0.370257	0.380492
e_0		**74.9**	**78.9**	**79.3**	**79.7**	**80.1**	**80.5**	**80.9**	**81.3**	**81.7**	**82.1**

Source: Author's calculations

Table 7.35: Key population indicators calculated from the population projection 2000-2050, Thailand 2000-based projection.

Indicators	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Number by sex (thousand)											
Total	62,236	65,186	67,990	70,340	71,980	72,882	73,058	72,498	71,217	69,467	67,281
Males	30,665	32,061	33,401	34,540	35,348	35,819	35,957	35,759	35,240	34,525	33,625
Females	31,571	33,125	34,590	35,800	36,631	37,063	37,101	36,739	35,977	34,942	33,656
Number by age group (thousand)											
Children (0-14)	15,343	14,836	14,077	13,597	12,729	11,711	10,471	9,253	8,085	7,171	6,471
Working (15-59)	41,026	43,500	45,619	46,492	46,472	45,658	44,406	42,817	40,963	38,771	36,287
Elderly (60+)	5,867	6,849	8,294	10,251	12,779	15,513	18,181	20,428	22,169	23,525	24,522
Elderly (65+)	3,871	4,675	5,666	6,862	8,529	10,739	13,118	15,397	17,263	18,645	19,703
Elderly (80+)	593	725	1,028	1,381	1,772	2,168	2,712	3,554	4,701	5,896	7,004
Population proportion (%)											
Children (0-14)	24.7	22.8	20.7	19.3	17.7	16.1	14.3	12.8	11.4	10.3	9.6
Working (15-59)	65.9	66.7	67.1	66.1	64.6	62.6	60.8	59.1	57.5	55.8	53.9
Elderly (60+)	9.4	10.5	12.2	14.6	17.8	21.3	24.9	28.2	31.1	33.9	36.4
Elderly (65+)	6.2	7.2	8.3	9.8	11.8	14.7	18.0	21.2	24.2	26.8	29.3
Elderly (80+)	1.0	1.1	1.5	2.0	2.5	3.0	3.7	4.9	6.6	8.5	10.4
Dependency ratio											
Child (0-14/15-59)	37.4	34.1	30.9	29.2	27.4	25.6	23.6	21.6	19.7	18.5	17.8
Aged (60+)	14.3	15.7	18.2	22.0	27.5	34.0	40.9	47.7	54.1	60.7	67.6
Aged (65+)	9.0	10.2	11.7	13.8	16.8	21.3	26.5	32.2	37.6	42.7	47.9
Growth rate (%)		0.95	0.86	0.69	0.47	0.25	0.05	-0.15	-0.35	-0.49	-0.63

Source: Author's calculations

The proportion of females is greater than males for the whole period of projection but the difference in proportions tend to decrease in the future. Although the total number of population increases in the first period of projection, the number of children aged 0-14 is projected to decrease for the whole period of projection. The number of children will decline more than half from 2000 to 2050. The proportion of children will reduce from 25 percent in 2000 to lower than 10 percent in 2050. The decrease in population is projected to occur not only in the child population but is also found in the working age group after 2020. While the number of children and working age population is projected to decrease, the reverse trend is found for the elderly population. The population aged 60 and over is projected to increase from 5.8 million in 2000 to 24.5 million in the next 50 years. The proportion of population aged 60 and over will rise from 9 percent to 36 percent within 50 years. Moreover, the proportion of population aged 80 and over is also projected to reach 10 percent in 2050. The change in age and sex structure of population in Thailand in the next 50 years is presented in Figure 7.5.

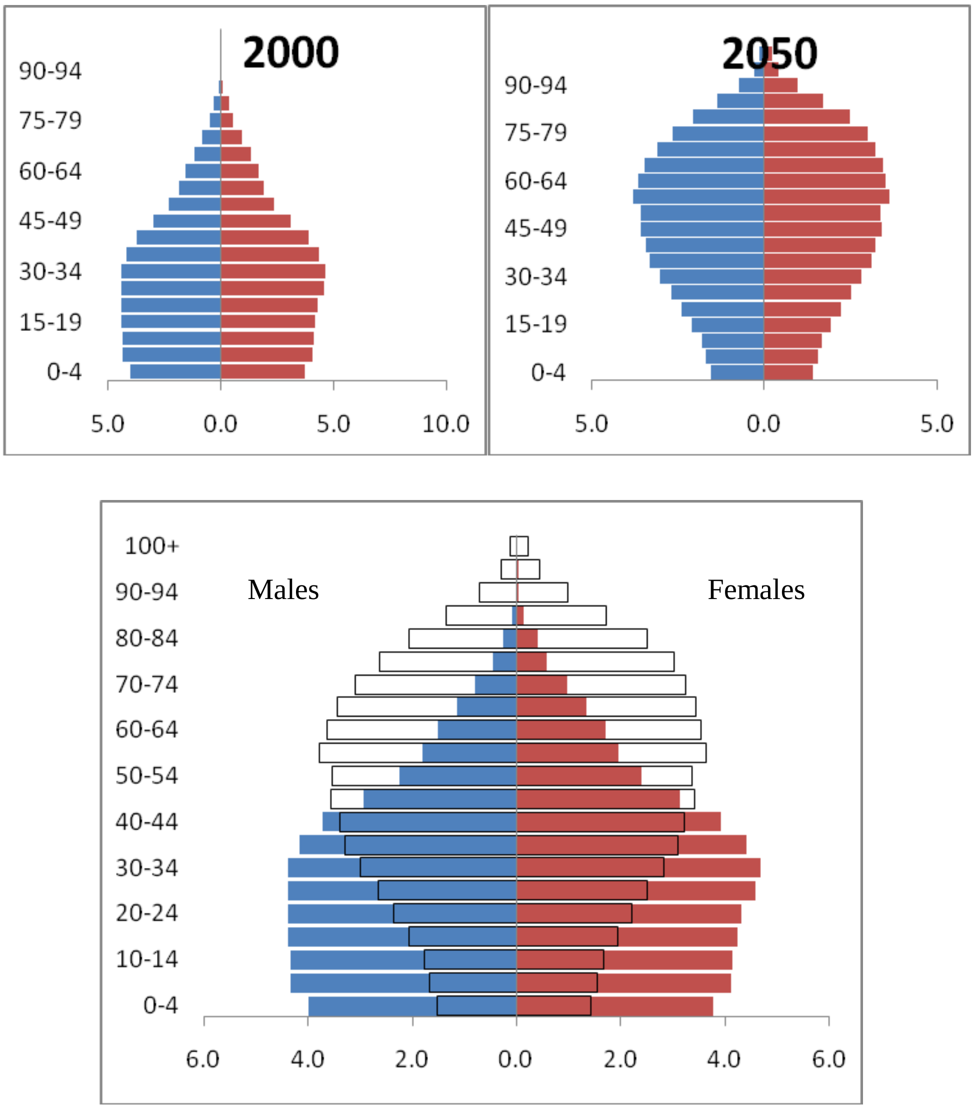


Figure 7.5: Age-sex structure of Thailand 2000 and 2050

Figure 7.5 shows that the proportion of old age population will increase whereas the proportion of working age population tends to decline. The proportion of population of children aged 0-14 was projected to decrease as well. This then leads to the rising of the aged dependency ratio. Moreover, the results in Table 7.35 show that if the working age is extended from age 60 to age 65, the aged dependency ratio will reduce around 20 percent in 2050.

The differences in the number of people in old age between sexes are found as presented in Figure 7.6. The number of females aged 60 and over is projected to be greater than males in the same age group in the next 50 years particularly in the middle period of projection. However, the gap between genders of population aged 60 and over tends to reduce after 2030. The differences in population numbers between male and female are also found in the population aged 80 and over. That means elderly females tend to live longer than males particularly in oldest old.

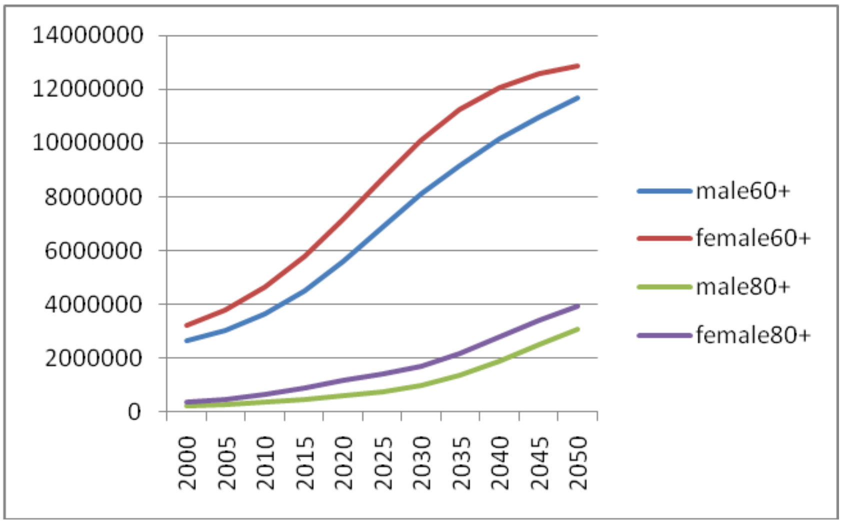


Figure 7.6: The population aged 60+ and 80+ by gender

7.7 Disability Projections

In this section, projections of the disabled elderly population (people aged 60 years and older) for Thailand have been made by age and sex. The aim of this analysis is to provide a detailed projection of the population by disability status for the period 2000 to 2050. The baseline estimates of the level of disability prevalence have been taken from the Surveys of Elderly in Thailand in 2002 and 2007. One of the most important factors affecting the ability of the elderly people to live independently is the onset of disability in activities of their daily lives (Reynolds and Silverstein 2003, Abramowska et al. 2005). In this study disability prevalence is measured from the limiting of Activities of Daily Living (ADLs) (Kunkel and Applebaum 1991). Definitions of functional disability vary widely. Some consider the impairment in one ADL as an indicator of long term disability. Others define long term disability in three or more ADLs. However, in this study we have defined disability as self-care disability and mobility disability as presented in Section 6.4 in Chapter 6.

7.7.1 The Assumptions of the Disability Projections

The projection of disability prevalence of the Thai population rates for 2000-2050 is calculated based on the disability prevalence rates obtained from the Surveys of Elderly in Thailand in 2002 and 2007. According to Chapter 6 disability is defined as the limitation in self-care activities and mobility activities. This study projected disability based on these two definitions. The prevalence rates of disability are available for two different base years of population projection as presented in Table 7.36.

Table 7.36: The prevalence rate of self-care disability and mobility disability in 2002 and 2007 by age and sex

	Male			Female		
Age group	**2002**	**2007**	**Change**	**2002**	**2007**	**Change**
Self-care disability prevalence (%)						
60-64	1.1	1.7	0.6	1.1	1.4	0.3
65-69	1.8	2.0	0.2	1.5	1.7	0.2
70-74	2.8	3.1	0.3	3.0	3.4	0.4
75-79	4.3	4.3	0.0	4.7	5.2	0.5
80-84	7.3	8.8	1.5	8.1	11.3	3.2
85-89	7.8	13.5	5.7	13.7	20.5	6.8 *
90-94	14.0	26.1	12.1	27.9	33.2	5.3
95+	14.3	20.7	6.4	21.8	40.5	18.7 *
Mobility disability prevalence (%)						
60-64	14.6	10.7	-3.9 *	33.9	22.2	-11.7 *
65-69	23.9	16.3	-7.6 *	47.5	32.2	-15.3 *
70-74	43.8	30.6	-13.2 *	66.4	52.9	-13.5 *
75-79	56.4	43.2	-13.2 *	76.9	62.5	-14.4 *
80-84	71.1	60.7	-10.4 *	81.9	79.4	-2.5
85-89	82.0	72.2	-9.8 *	89.9	87.7	-2.2
90-94	85.6	87.4	1.8	93.4	93.3	-0.1
95+	80.0	82.1	2.1	92.9	93.5	0.6

Source: Author’s calculations
Note: * is significant difference at 5% level

The disability projections are calculated based on two different methods. The first is the applied linear model and the second is the exponential model.

The linear model for disability projection is calculated based on equation below.

$$D_{t+n} = D_t + bn \tag{7.20}$$

$$b = (D_{t+n} - D_t)/n \tag{7.21}$$

where

D_{t+n} = Disability prevalence at time t+n,

D_t = Disability prevalence at time t,

b = Difference of the disability prevalence per year,

n = Difference between time t+n and t,

The exponential model for disability projection is calculated thus:

$$D_{t+n} = D_t \times e^{bn} \tag{7.22}$$

$$b = (\ln D_{t+n} - \ln D_t)/n \tag{7.23}$$

The results of projected self-care disability prevalence rates show that there are some age groups which their prevalence rates exceed 100 percent. This implies that all of the population are disabled. The projected prevalence rates based on the disability trends from the Survey of Population in Thailand in 2002 and 2007 using linear model and exponential model are unreliable. The alternative is to assume that an average of 2002 and 2007 disability prevalence rates will continue over the projection period as shown in Table 7.37. To project the disabled population for Thailand in 2000 to 2050, these average disability prevalence rates are applied with the new population projection for Thailand in Section 7.6.

Table 7.37: The base self-care disability and mobility disability prevalence rates for disabled population projection for Thailand 2000-2050

Disability Prevalence Rates (%)		
	Self-care	**Mobility**
	2000	**2000**
Males		
60-64	1.4	12.7
65-69	1.9	20.1
70-74	3.0	37.2
75-79	4.3	49.8
80-84	8.1	65.9
85-89	10.7	77.1
90-94	20.1	86.5
95+	17.5	81.1
Female		
60-64	1.3	28.1
65-69	1.6	39.9
70-74	3.2	59.7
75-79	5.0	69.7
80-84	9.7	80.7
85-89	17.1	88.8
90-94	30.6	93.4
95+	31.2	93.2

Source: Author's calculations

To obtain the projected disabled population, the assumption about what would happen to disability prevalence in the future has been made for the next 50 years. The assumptions on trend of disability prevalence rates are divided into three assumptions. First is the constant disability prevalence rates assumption which given the disability prevalence rate at base year (2000) constant for the whole period of projection (2000-2050). Second assumption is 2 percent decrease of the disability prevalence rate for every 5 years. Third assumption is a 2 percent increase of the disability prevalence rate for every 5 years. These assumptions are applied for both the self-care disabled and mobility disabled population projection to investigate the impacts of disability prevalence trends in old age.

7.7.2 The Results of Disabled Population Projections

The results of the disabled population projections are shown in Table 7.38. Based on disability constant assumption, the self-care disabled population is projected to increase both for males and females from 2000 to 2050. The proportion of male population aged 60 and over who live with self-care disability will increase from 2.8 percent in 2000 to 4.8 percent in 2050. The proportion of oldest old who live with self-care disability is projected to exceed 10 percent. The number of elderly population who live with self-care disability and mobility disability for Thailand, 2000-2050 is shown in Appendix C.

Table 7.38: The number and percentage of population who live with self-care disability and mobility disability in Thailand 2000, 2025 and 2050

Self-care Disabled Population				Mobility Disabled Population			
	2000	**2025**	**2050**		**2000**	**2025**	**2050**
Constant				**Constant**			
Males				**Males**			
60+	74,402	214,231	556,163	60+	744,106	2,041,185	4,628,048
80+	21,187	78,000	340,194	80+	159,972	540,669	2,194,658
60+(%)	2.8	3.1	4.8	60+(%)	28.0	29.8	39.6
80+(%)	9.2	10.3	11.1	80+(%)	69.4	71.4	71.7
Females				**Females**			
60+	109,456	391,663	890,102	60+	1,538,344	4,391,212	7,578,059
80+	45,993	224,979	653,087	80+	302,102	1,185,075	3,272,990
60+(%)	3.4	4.5	6.9	60+(%)	47.9	50.8	59.0
80+(%)	12.7	15.9	16.6	80+(%)	83.4	84.0	83.0
2% Decreased				**2%Decreased**			
Males				**Males**			
60+	74,402	193,648	454,426	60+	744,106	1,845,069	3,781,452
80+	21,187	70,506	277,963	80+	159,972	488,722	1,793,196
60+(%)	2.8	2.8	3.9	60+(%)	28.0	26.9	32.4
80+(%)	9.2	9.3	9.1	80+(%)	69.4	64.6	58.6
Females				**Females**			
60+	109,456	354,032	727,278	60+	1,538,344	3,969,308	6,191,826
80+	45,993	203,363	533,620	80+	302,102	1,071,214	2,674,272
60+(%)	3.4	4.1	5.7	60+(%)	47.9	45.9	48.2
80+(%)	12.7	14.4	13.5	80+(%)	83.4	75.9	67.8
2% Increased				**2% Increased**			
Males				**Males**			
60+	74,402	236,528	677,960	60+	744,106	2,253,633	5,641,565
80+	21,187	86,118	414,694	80+	159,972	596,943	2,675,276
60+(%)	2.8	3.4	5.8	60+(%)	28.0	32.8	48.3
80+(%)	9.2	11.4	13.6	80+(%)	69.4	78.8	87.5
Females				**Females**			
60+	109,456	432,427	1,085,029	60+	1,538,344	4,848,253	9,237,611
80+	45,993	248,395	796,110	80+	302,102	1,308,419	3,989,757
60+(%)	3.4	5.0	8.4	60+(%)	47.9	56.0	71.9
80+(%)	12.7	17.6	20.2	80+(%)	83.4	92.7	101.1

Source: Author's calculations

When we compare between genders, the results show that the elderly population who live with self-care disability tends to increase both for males and females as presented in Figure 7.7. However, the number and the proportion of self-care disabled females are higher than males. An increase in the number of self-care disabled population is found when a decreased prevalence rate was applied. The percentages of population who live with self-care disability obtained from prevalence rate decreasing scenario are projected to decrease in population aged 80 and over both for males and females but for population aged 60 and over, the proportion of self-care disabled population still increase. Based on disability increased 2 percent per five years assumption, the self-care disabled population is projected to increase both for males and females from 2000 to 2050. The proportion of population aged 60 and over who live with self-care disability will increase almost double between 2000 and 2050. The proportion of oldest old who live with self-care disability is projected to exceed 10 percent and reach 20 percent in 2050 for females. When we compare between genders, the results show that the increasing of elderly population who live with self-care disability tend to increase both for males and females but the increasing rate in females is higher than males in all age groups.

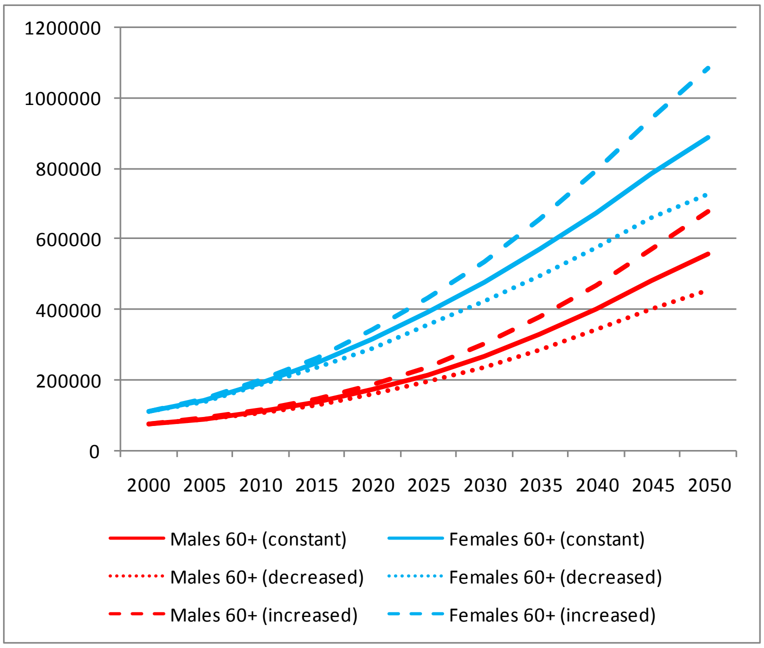


Figure 7.7: The absolute number of self-care disabled population in 2000-2050 based on constant disability prevalence, 2 percent decreased and 2 percent increased of prevalence

The results of mobility disabled population projection show the same trend as occurs with self-care disability projection. The absolute number of elderly population who will face mobility limitation will increase in the next 50 years for all three scenarios. However, the absolute number of mobility disabled females aged 60 and over are projected to the higher than males in the first half of the projection period and then tend to be lower than males in the second half of projection as shown in Figure 7.8. This might because of the mobility prevalence rates in males increased more than females older old age. When the number of older old was projected to increase in the next 50 years, so the number of the population with mobility disability increased.

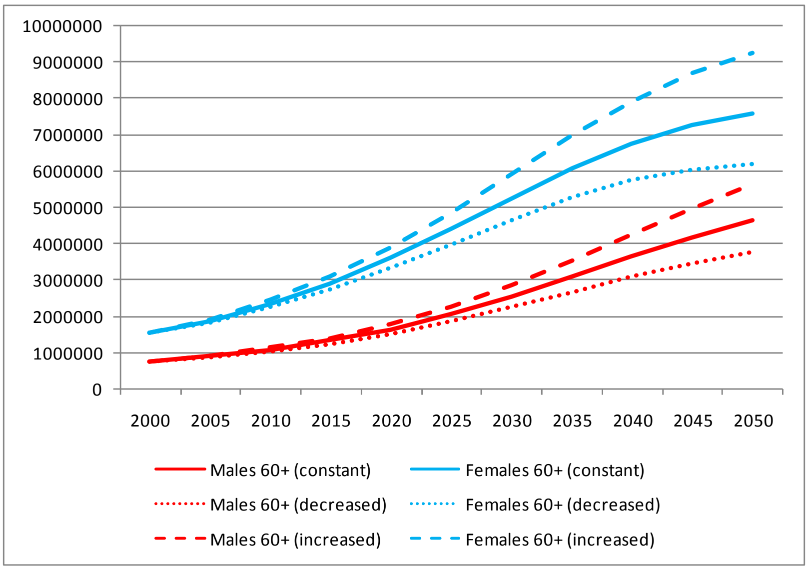


Figure 7.8: The absolute number of mobility disabled population in 2000-2050 based on constant disability prevalence, 2 percent decreased and 2 percent increase of prevalence

The proportion of mobility disabled population aged 60 and over is projected to increase based on the constant scenario both for males and females, whereas the proportion of population aged 80 and over tends to decrease. The decreasing scenario projected that the proportion of population aged 60 and over with mobility disability will decrease in the first period of the projection and then increase in the rest of the projection period. This trend will occur both for males and females. However, if the mobility disability prevalence rate is decreased 2 percent per five years, the proportion of population aged 80 and over who suffered from limitation in mobility activities will continue to decline in the next 50 years. This might be the affect of the absolute number of younger old age will rising rapidly in next 50 years. The proportion of mobility disabled population is projected to increase in both younger old age and older old age based on the 2 percent increase scenario both for males and females. However, the proportion of older old age lived with mobility disability is projected to be much higher than younger old age.

7.8 Discussion and Conclusions

In this Chapter, the population projections for Thailand between 2000 and 2050 by the United Nation (UN), the National Economic and Social Development Board (NESDB) and the author are explored, investigated and developed. Both the projection assumptions and their outcomes as summarised in Table 7.39. All three analyses projected that the population in Thailand will increase between 2000 and 2025 and then will reduce between 2025 and 2050.

These trends of population change for Thailand in the future are the same for all three projections although their population assumptions are different. However, the proportion of the projected population by age groups from the three projections indicated that the proportion of children (ages 0-14) and working age population (ages 15-64) tend to reduce in the next 50 years. The decrease in the proportion of the children and working age group is the result of the reduction of total fertility rate (TFR) in the fertility assumption during the projection period. Moreover, the mortality assumption of a projection of continuing increase in life expectancy at birth leads to a rising proportion of older people and an increasing old age dependency ratio, as summarised in Table 7.39. The TFR and the mortality rates in the author’s projection are projected to be lower than the UN projection. The proportion of children is projected to be lower in the author’s projection than in the UN whereas the proportion of elderly and the old age dependency ratio are projected to be higher in the author’s projection.

Table 7.39: The population projections by UN, NESDB and the Author for Thailand between 2005 and 2050.

Projection Assumptions	2005-2010		2020-2025		2045-2050	
Fertility (TFR)						
UN	1.85		1.85		1.85	
NESDB	1.79		1.71		n.a.	
Author	1.73		1.45		1.09	
Mortality (e_0)	**M**	**F**	**M**	**F**	**M**	**F**
UN	66.5	75.0	70.3	77.4	74.9	81.1
NESDB	69.6	76.2	74.8	80.3	n.a.	n.a.
Author	72.3	78.9	75.9	80.1	82.0	82.1
Migration (Net Migration)						
UN	35,000		20,000		20,000	
NESDB	0		0		n.a.	
Author	46,500		46,500		46,500	
Projection Results (both sexes combined)						
Total Pop (Millions)						
UN	65.1		68.8		67.4	
NESDB	67.0		72.3		n.a.	
Author	68.0		72.9		67.3	
Proportion of 0-14 (%)						
UN	20.6		17.9		15.8	
NESDB	21.3		18.0		n.a.	
Author	20.7		16.1		9.6	
Proportion of 15-64 (%)						
UN	70.7		67.2		60.9	
NESDB	70.9		68.4		n.a.	
Author	71.0		69.2		61.1	
Proportion of 65+ (%)						
UN	8.7		14.9		23.3	
NESDB	7.8		13.7		n.a.	
Author	8.3		14.7		29.3	
Old Age Dependency Ratio						
UN	12.3		22.3		38.2	
NESDB	11.0		20.0		n.a.	
Author	11.7		21.3		47.9	

Source: Author's calculation

The projections for Thailand as discussed above imply that the number of people who reach old age is projected to increase in the future. While the decline in fertility rate in Thailand in the period of projection leads to decreases in the younger age group. The consequence of a change in age structure of population in Thailand in the future is the rising of the aged dependency ratio. Extending the retirement age in the future might be one of the strategies for Thailand to cope with the rise in the aged dependency ratio. Moreover, based on the new population projection (author's projection) the proportion of population aged 80 and over increases rapidly in the next 50 years as found in the UN population projection for Thailand (United Nations 2006b). The proportion of old age females was also expected to be higher than males in all age groups, especially in the oldest old. This might be the result of the difference in life expectancy between males and females.

Because the disability prevalence rate in old age tends to increase with age, the increase in the old age population leads to the increasing of the disabled population in absolute number. Results from this work showed that based on the constant and increased disability prevalence assumption the absolute numbers of disabled males and females tend to increase between 2000 and 2050. Based on the constant assumptions the absolute numbers of disabled persons will increase as an effect of the ageing of the population in constant assumption. While both the effects of ageing of the population and increasing of disability in old age are causes of increase number of old age population in disability. The disabled population projection for Thailand based on a decreasing prevalence rate assumption also shows the increase in the absolute number of the disabled population. In addition, the numbers of disabled females always remains higher than those of disabled males due to their lower mortality and their higher age-specific disability prevalence (Giles et al. 2003). The projections of the disabled population in this study assumed that trends in the disability prevalence are constant, decreased or increased by 2 percent per five years. The projection of disability based on the prevalence obtained from the trend between 2002 and 2007 is unreliable. The data came from only two points of time and probably do not represent trends in disability. A series of disability surveys will be needed for Thailand to provide more reliable disability trends. However, the questions of disability or disability indicators need to be the same for the whole series of the survey.

The rapidly increasing number of the elderly population will likely have a number of significant economic consequences. These include the possibility of overwhelming social security funds especially in the case of developing countries, and an expansion of unmet financial needs of the elderly (Lloyd-Sherlock 2000, Mayhew 2000). The rising numbers of dependents related to ageing could also result in negative demographic dividend. There is also concern that an ageing population would have large effects on health expenditures both public and private (Mahal and Berman 2001). In the next chapter, the relationship between ageing and health spending will be explored and a projection of health expenditures in the future will be generated.

CHAPTER 8
THE CONSEQUENCES OF AGEING FOR POLICY IN THAILAND

8.1 Introduction

Thailand has recently experienced downward transitions in mortality and fertility rates. The consequences of the reductions are population ageing and labour shortages. Population ageing will persist in future decades. Moreover, the fertility decline is expected to have a negative impact on the family support for the elderly and the size of the working age population. Population ageing will also increase the demand for health care services as the elderly are a vulnerable population. The increasing numbers of older people especially those who are in poor health or disability (Chapter 6 and Chapter 7) that results from the expansion of morbidity in old age will increase demand for health care services particularly long-term care. The policies related to population ageing in Thailand should be focused on managing health care expenditures, developing the long-term care system, organizing social security and funding pensions, which will be discussed in the following sections. This chapter aims to understand the implications for policy of our results on future populations (Chapter 7, Sections 7.6), healthy life expectancy (Chapter 6), and changes in health status in old age (Chapter 7, Section 7.7). Then to achieve this aim, the chapter considers population ageing in Section 8.2, the consequences of ageing for socioeconomic support in Section 8.3, the consequences of ageing for health care services in Section 8.4 and for health care expenditure in Section 8.5. We then review current policies on ageing in Thailand in Section 8.6. The chapter concludes in Section 8.7 with a discussion of findings.

8.2 Population ageing in Thailand

Thailand is now experiencing a rapid increase of older people. This process is projected to persist in the future as presented in Figure 8.1. The number of people aged 60+ was 5.9 million in 2000 and is projected to rise to 21.1 million in 2050. The population aged 60+ will increase nearly four times within 50 years. The proportion that is aged 60+ is projected to increase from 9 percent in 2000 to 30 percent in 2050. Moreover, the older population in Thailand has itself been ageing: the percentage of the population aged 60+ who are aged 80+ has increased. Figure 8.2 shows that the 80+ population increased from 10 percent to 24 percent while the population aged 60 to 69 decreased from 60 percent in 2000 to 42 percent in 2050. This means that, in the next 50 years, Thailand will have one person aged 80+ for every four older persons aged 60+. Thailand then not only faces population ageing but also the ageing of the older population.

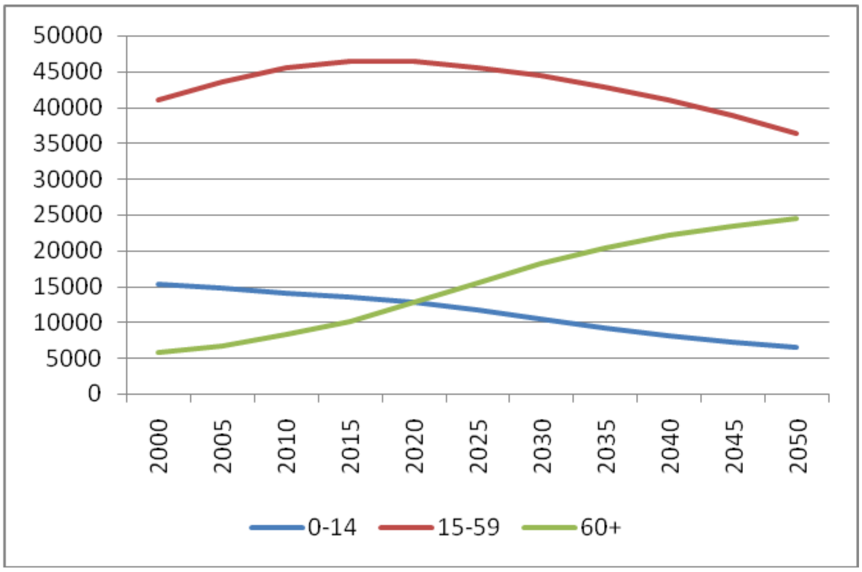


Figure 8.1: Projected populations (thousands) by age group, 2000-2050, Thailand
Source: Computation from author's Thailand population projection 2000 to 2050 (Chapter 7)

The data on life expectancy in Thailand show that elderly women tend to live longer than men. In 2007, life expectancy for men aged 65 was 16.8 while the life expectancy for women was 18.9 years. Due to this trend, the proportion of females aged 60+ is higher than the proportion of males as presented in Figure 8.3. This is known as the feminization of population ageing (UNFPA 2006a).

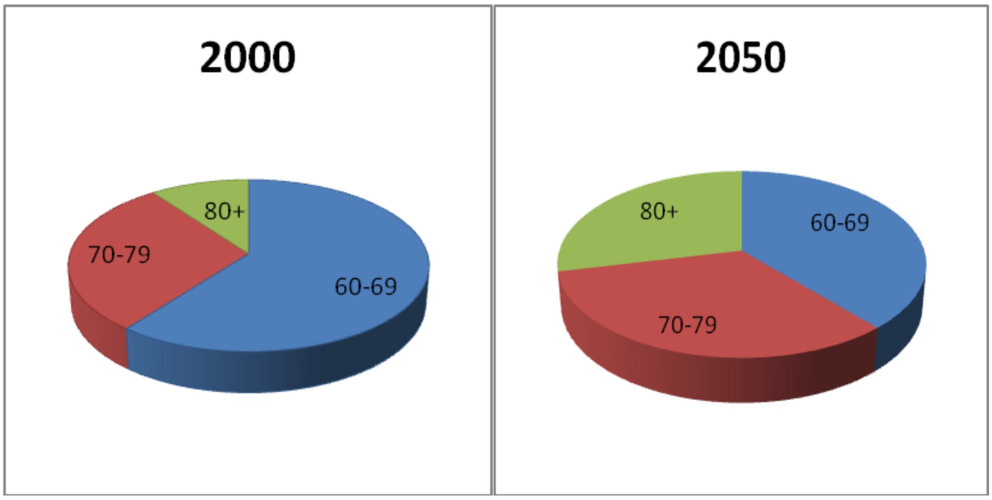


Figure 8.2: The age composition of the population aged 60+, 2000 and 2050, Thailand
Source: Computation from author's Thailand population projection 2000 to 2050 (Chapter 7)

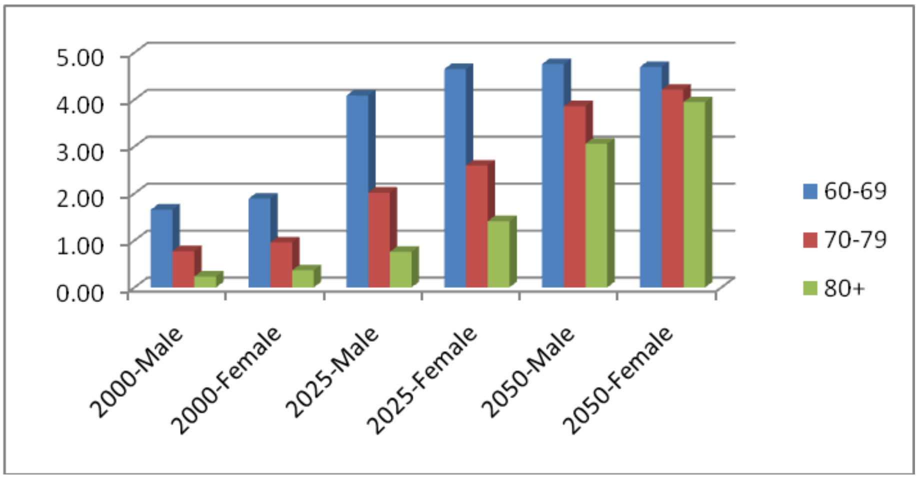


Figure 8.3: Number of elderly by age and gender (millions)
Source: Computation from author's Thailand population projection 2000 to 2050 (Chapter 7)

The increase of the number and proportion of older people, particularly the population aged 80+ and the rise in female population, challenge Thailand in various dimensions. Generally the consequences of population ageing are the rising demand for socioeconomic support and the increasing demand on health services and health expenditure.

8.3 The consequences of ageing for socioeconomic support

The key socioeconomic consequence of population ageing stems from the ratio of old age people relative to the economically active population. This is known as the conventional old age dependency ratio. There are two dependency ratios; the child dependency ratio which is the ratio of population aged 0-14 to the population aged 15-59 and the conventional old age dependency ratio which is defined as the proportion of population aged 60 and over to the population aged 15-59 as presented in Figure 8.4 as a percentage. The graph also plots the old age dependency ratio redefined in two ways: the old age threshold is raised to 70+ and the working ages are adjusted to 20-69. The new old age dependency ratio is much lower than the conventional old age dependency ratio.

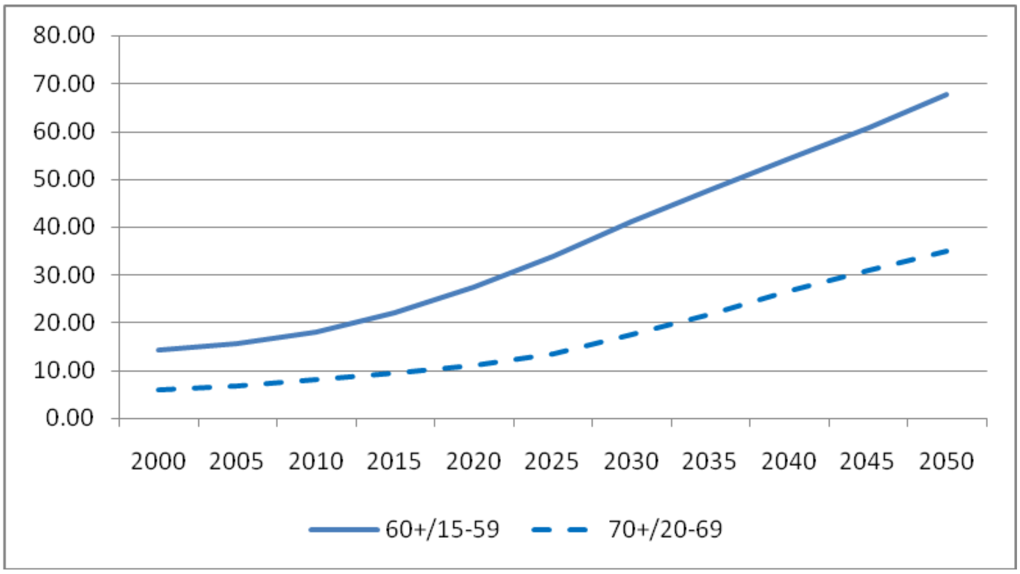


Figure 8.4: The old age dependency ratios for Thailand between 2000 and 2050
Source: Computation from author's Thailand population projection 2000 to 2050 (Chapter 7)

As the proportion of the elderly population is projected to increase while the proportion of economically active population is projected to decrease, then the old age dependency ratio also increases. The rise of this ratio might imply that the demand for economic support of old people is increasing at the same time as the capacity to provide that support is decreasing. However, a recent study reported that the enrolment in education is higher in the population aged 15-19 and that the proportion of not working population in this age group has been rising (UNFPA 2006b). If the potentially economically active population is defined as the population aged 20-69 and the age of retirement increases to 70 then, the old age dependency ratio is much lower, as presented in Figure 8.4. Population ageing will lead to concerns about national income, pension and health care cost if this population is rising with bad health (Coory 2004), particularly if the retirement age of population in Thailand remains at 60. Then, employment in old age will be an important factor in financial security. But the chance to find gainful employment in old age is more difficult because agriculture is the major source of employment of elderly people particularly in rural areas. Moreover, due to the economic crisis, the education level and the increase of labour saving technology in the industrial sector lead to lower chances for elderly population to be employed in this sector. Elderly women will suffer a worse impact as a result of economic development because they lack education and training. As most of them are economically inactive then the rising proportion of women in old age will directly impact on national income and financial support.

In Thailand, as in other developing countries, there is lack of universal retirement state benefit. Thus the increase in the older population leads to a greater reliance on family support (UNFPA 2006b). In Thailand, co-residence of the elderly population with their children or grandchildren is the norm (UNFPA 2008). Traditionally, it is the offspring who take responsibility for the care of parents in their old age. However, due to fertility decline the number of children has decreased, thus elderly people have fewer opportunities to live with their offspring (UNFPA 2008). The parent support ratio can be calculated as the ratio of population aged 85+ to the population aged 55-64 years and the ratio of population aged 75+ to the population aged 45-54 years which are shown in Figure 8.5. This ratio reflects the demand placed by population ageing on offspring, assuming that offspring have been born to parents when they were in their twenties and thirties. The parent support ratios show that these ratios will increase, particularly in the 75+ age group of elderly population. These result from increases in the numbers of older people combined with decreases in the number of younger people. The increasing parental support ratios result from the reduction of family size. However, the increase in this ratio means there is a growing need for ensuring adequate financial support and care to the elderly by society as a whole because the reduction of family support might lead to the increase of elderly who live alone, particularly elderly women. Because this social support will need to be funded, taxes will need to rise. This need not be problematic, provided economic growth and income continue to rise.

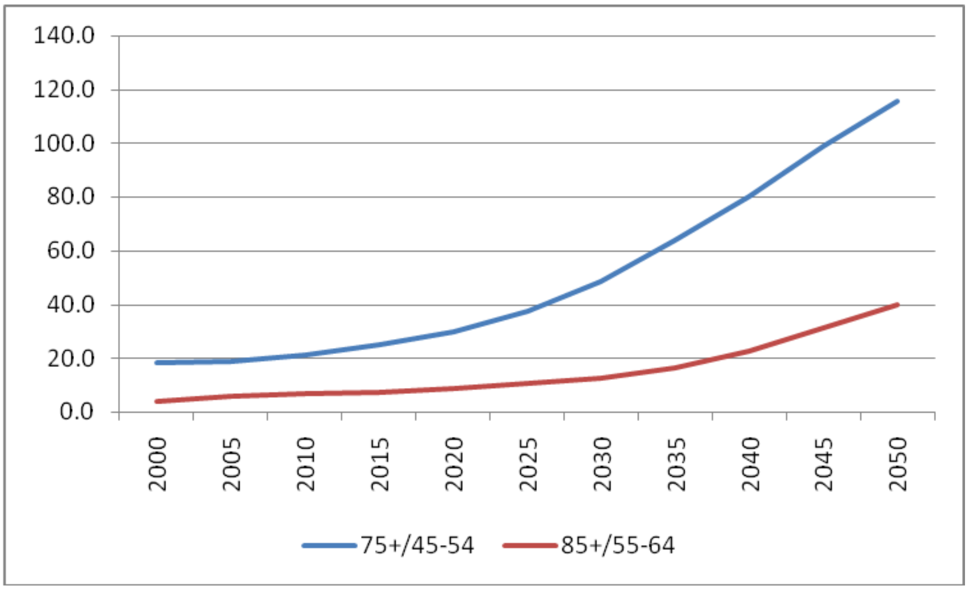


Figure 8.5: The parent support ratio 2000-2050, Thailand
Source: Computation from author's Thailand population projection 2000 to 2050 (Chapter 7)

The alternative to family support for ensuring income security for old age is social security in the form of a pension. However, in Thailand the pension scheme is limited (UNFPA 2008). It covers only those who have had employment with state or public enterprises that have pension benefits while most of the elderly population have worked in the informal sectors such as agriculture and services. Moreover, as the pension benefits depend on an individual's past contributions to a pension plan or scheme then the reduction of economically active population means a smaller number of workers are available to contribute towards paying for the pensions of a growing number of older persons. The increase of elderly women will also affect the pension scheme due to their low rate of employment participation. The government should design policies that cope with the increasing number of people who have to be paid and the payment will have to last longer than in the past.

Welfare benefits are the other options for social security in old age. Benefits are different from pension schemes because they do not depend on the past contributions but are based on age or need. Welfare benefits can be found in the form of monthly payments or the provision of free or subsidized services or materials. In Thailand the welfare benefits are represented by the monthly payment of 300 Baht (UNFPA 2006a). However, this amount is low and not sufficient and the coverage is low.

8.4 The consequences of ageing for health care services

Our analysis of healthy life expectancies in Thailand (Chapter 6 and 7) shows that the older population are expected to live longer but with more life time spent in poor health or disability particularly health based on self-rated health and self-care disability. So this might increase the cost of health care. However, the burden of health depends on both the trend in health status and the changing population structure. Our population projection by health status used the assumption that the disability prevalence rate constant, decreased by 2 percent every 5 years and increased by 2 percent every 5 years. Nevertheless the projections showed that the number of elderly people unable to take care of themselves is projected to increase from 2000 to 2050 even though 2 percent decrease every 5 years was assumed in the projection as presented in Figure 8.6. The reason for the increase in older people with disability is that they live longer to become members of the “oldest old” age group, who are much more frail. This means that the elderly population in Thailand tend to live longer and because the rate of increase of the elderly is very fast, there is an increase of the disabled population.

There are several studies which show that the chance of moving from active to disabled status is increased with age. The increase of the older population implies high demand for long-term care and increasing health expenditure. Moreover, the majority of elderly Thai are women who are projected to have higher rate of disability than men. Elderly women tend to live longer but their healthy life expectancies are smaller than men of the same age. The health spend in old age is normally the result of illness and disability (Legare 2006). The increase of disabled elderly people in Thailand will lead to concern about long term care, health care cost and health expenditure. These costs tend to increase while income (GDP) tends to decrease due to the rise in retired population (Wongboonsin et al. 2005). How will Thailand manage the imbalance between the payments and the benefits?

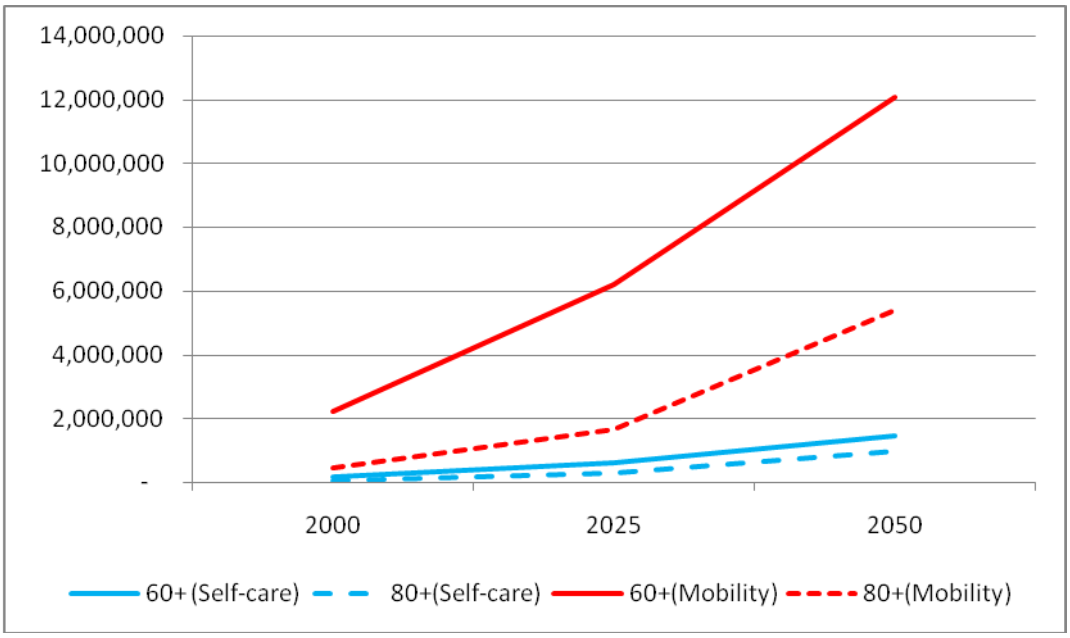


Figure 8.6: The projected number of disabled population (aged 60+) by different type of disability
Source: Computation from author's Thailand health projection 2000 to 2050 (Chapter 7)

8.5 The consequences of ageing for health expenditures

A key issue is the consequence of population ageing on health care costs and services (Desai and Tye 2009). The change in biomedical processes in old age can cause a rise in health care demand in this population particularly in later life when disability and dependency reach their maximum level. Most of the studies confirm that the older ages consume more health services per capita than other age groups except the new born (Mayhew 2000). However, there are also other factors that relate to health expenditure in old age such as technological change, institutional arrangements for health care in old age and the higher health service utilisation per capita. An OECD projection has shown that half of the increase in age related social expenditures between 2000 and 2050 for OECD countries involve the health and long term care costs, which will rise from 19 percent of GDP in 2000 to 26 percent in 2050 (Gray 2005). However, the methods of the projection have been questioned.

There is also some evidence suggesting that the increase in the number of old people might not lead to an increase in the demand of health care, because future generations are likely to experience longer but healthier lives (Rechel et al. 2009). They will also be better prepared to live independently in advanced age particularly with the aid of modern technologies. Furthermore, future generations of older people are expected to work longer than past generations. In recent years the economic impacts of population ageing are concerned to many countries, especially the developing world. The increasing rate of ageing in these countries is faster than in the developed countries. This means developing countries are going to spend a lot of their national income on health care. Then the issue is how to manage these growing demands. How will population ageing affect health expenditure and how much share of the national income (GDP) will be needed? Furthermore, how government policies are designed to manage these impacts is contentious.

Overall health expenditure for Thailand has increased rapidly in recent decades both for total and per capita health expenditure, as shown in Table 8.1. During the past 25 years, total health expenditure in Thailand has increased from 25,315 million baht in 1980 to 434,974 million baht in 2005 (The exchange rate on 19 August 2010, 1 GBP = 50.10 THB and 1 USD = 31.83 THB). The per capita health expenditure also increased at the same pace as the total. It reached 7,000 baht in 2005 whereas per capita health expenditure was only 545 baht in 1980. It increased about 12 times within 20 years (Ministry of Public Health 2008).

The percentage of the health expenditure on GDP also rose from 3.8 percent in 1980 to about 6 percent in 2005, a 60 percent increase over the 25 years. These trends of rising health expenditure of Thailand are related to the increase in the age make-up of the population. The data published for Thailand on health spends are limited to the total and per capita health expenditure for all ages together. The data did not provide details of health expenditure for age-sex groups. However, it is important to estimate the impact of population ageing on health spend for health planning purposes. This study attempts to estimate and project the health expenditure by age group and gender by borrowing the New Zealand health expenditure profile by age and sex, adjusted to Thai levels of total health spend.

Table 8.1: Health expenditure for Thailand 1980-2005

Health Expenditure							
Year	Total (million baht)	Per capita (baht)	As % of GDP	Inflation rate %	inflation index	In constant 2005 baht	Time series (1980=100)
1980	25315	545	3.82	19.7	2.62	66359	100
1981	31755	669	4.18	12.7	2.19	69541	105
1982	34873	719	4.14	5.3	1.94	67763	102
1983	41181	833	4.47	3.7	1.85	75993	115
1984	52241	1037	5.29	0.9	1.78	92963	140
1985	59265	1147	5.61	2.4	1.76	104521	158
1986	66060	1255	5.83	1.8	1.72	113774	171
1987	75704	1439	5.82	2.5	1.69	128079	193
1988	89968	1650	5.77	3.8	1.65	148499	224
1989	105091	1895	5.66	5.4	1.59	167110	252
1990	125302	2224	5.74	-9.5	1.51	189040	285
1991	138818	2450	5.54	5.7	1.67	231416	349
1992	157965	2753	5.58	4.2	1.58	249135	375
1993	184062	3142	5.81	3.3	1.51	278593	420
1994	199949	3405	5.51	5.1	1.47	292971	441
1995	227477	3838	5.43	5.8	1.39	317132	478
1996	257507	4307	5.58	5.9	1.32	339317	511
1997	282001	4664	5.96	5.6	1.24	350890	529
1998	276090	4515	5.97	8.1	1.18	325317	490
1999	284235	4616	6.13	0.3	1.09	309819	467
2000	299757	4853	6.09	1.5	1.09	325761	491
2001	321239	5173	6.26	1.6	1.07	343948	518
2002	333798	5336	6.12	0.7	1.05	351766	530
2003	370206	5882	6.24	1.8	1.05	387422	584
2004	392829	6283	6.05	2.8	1.03	403828	609
2005	434974	6994	6.14	4.5	1.00	434974	655

Source: Ministry of Public Health, Thailand 2008, IMF 2009
http://www.indexmundi.com/thailand/inflation_rate_(consumer_prices).html
Note: The exchange rate on 19 August 2010, 1 GBP = 50.10 4.6THB and 1 USD = 31.83 THB

The estimation of health expenditure for Thailand using New Zealand's age disaggregated health expenditure is accomplished in the following steps.

Step 1. Adjust the health spend for Thailand by calculating the mid-year to mid-year inflation rate as follows (Table 8.2);

$$IR_{y,\ y+1} = (IR_y + IR_{y+1})/2 \qquad (8.1)$$

where: $IR_{y,\ y+1}$ is the Inflation Rate for mid-year y to mid-year y+1 and

IR_y, IR_{y+1} are the inflation rates for calendar years y and y+1

Table 8.2: Calculation of the mid-year to mid-year inflation rate for Thailand (Step 1)

Year	**calendar year** **Thailand inflation rate (%)**	**mid-year to mid-year** **Thailand inflation rate (%)**
(y)	**(IR)**	**($IR_{y,y+1}$)**
2000	2.4	2.25
2001	2.1	1.85
2002	1.6	1.10
2003	0.6	1.20
2004	1.8	2.30
2005	2.8	3.65

Source: Author's calculations

Step 2. Calculate the inflator index for 2000 to 2005 based on 2009 prices as follows (Table 8.3):

$$II_{y-1} = II_y[(100+IR_{y-1,y})/100] \qquad (8.2)$$

where: II_y is the Inflator Index for year y.

The II_{2009} value is set to 1.00. The resulting Inflator Index for 2000 is 1.28. That means we need to inflate current expenditure in 2000 by 28% to re-express 2000 expenditure in 2009 baht.

Table 8.3: Calculation of the inflator index for 2000 to 2005 based on 2009 prices (Step 2)

	calendar year	**mid-year to mid-year**	**2009 constant prices**
Year	**Thailand inflation rate (%)**	**Thailand inflation rate (%)**	**Inflator index**
(y)	**(IR)**	**($IR_{y,y+1}$)**	**(II)**
2000	2.4	2.25	1.27
2001	2.1	1.85	1.25
2002	1.6	1.10	1.22
2003	0.6	1.20	1.21
2004	1.8	2.30	1.20
2005	2.8	3.65	1.17

Source: Author's calculations

Step 3. Calculate the Thailand health expenditure spend in 2000 to 2005 based on 2009 constant baht by multiplying the health spend in each year with the inflator index of that year (Table 8.4).

$$S_y = C_y * II_y \tag{8.3}$$

where: S_y is the spend in year y in 2009 baht, and C_y is the spend in year y baht.

Step 4. Calculate the New Zealand inflator index for 2000 to 2008 based on 2009 constant prices in the same way as in Thailand applying steps 1 and 2 (Table 8.5).

Table 8.4: Calculation of the health spend in 2000 to 2005 based on 2009 constant baht (Step 3)

Year	calendar year Thailand inflation rate (%)	mid-year to mid-year Thailand inflation rate (%)	2009 constant prices Inflator index	Millions of Baht Current spend	Millions of Baht Spend in 2009 constant Baht
(y)	(IR)	($IR_{y,y+1}$)	(II)	(C_y)	(S_y)
2000	2.4	2.25	1.27	299757	382039
2001	2.1	1.85	1.25	321239	400408
2002	1.6	1.10	1.22	333798	408505
2003	0.6	1.20	1.21	370206	448132
2004	1.8	2.30	1.20	392829	469878
2005	2.8	3.65	1.17	434974	508592

Source: Author's calculations

Table 8.5: Calculation for the mid-year to mid-year inflation rate and inflator index for 2000 to 2005 based on 2009 prices for New Zealand (Step 4)

Year	calendar year Thailand inflation rate (%)	mid-year to mid-year Thailand inflation rate (%)	2009 constant prices Inflator index	Millions of Baht Current spend	Millions of Baht Spend in 2009 constant Baht	mid-year to mid-year New Zealand inflation rate (%)	2009 constant prices Inflator index
(y)	(IR)	($IR_{y,y+1}$)	(II)	(C_y)	(S_y)	($IR_{y,y+1}$)	(II)
2000	2.4	2.25	1.27	299757	382039	3.33	1.28
2001	2.1	1.85	1.25	321239	400408	2.40	1.24
2002	1.6	1.10	1.22	333798	408505	2.33	1.21
2003	0.6	1.20	1.21	370206	448132	1.75	1.18
2004	1.8	2.30	1.20	392829	469878	2.70	1.16
2005	2.8	3.65	1.17	434974	508592	3.48	1.13

Source: Author's calculations

Step 5. Calculate the New Zealand health expenditure spend in 2001 when age-sex disaggregated health spend per capita is available based on 2009 constant prices by multiplying the health spend in 2001 by age group and gender with the inflator index of 2001 for New Zealand dollars (Table 8.6).

Table 8.6: Calculation for New Zealand per-capita health spend in 2001 adjusted for 2009 price (Step 5)

Age group	New Zealand Per capita Health Spend in 2001 (price at 2001 NZ$)	2009 Constant prices, Inflator index at 2001	New Zealand Per capita Health Spend in 2001 (price at 2009 NZ$)
Males			
0-4	1,877	1.24	2,327
5-9	723	1.24	897
10-14	658	1.24	816
15-19	843	1.24	1,045
20-24	881	1.24	1,092
25-29	930	1.24	1,153
30-34	905	1.24	1,122
35-39	937	1.24	1,162
40-44	986	1.24	1,223
45-49	1,218	1.24	1,510
50-54	1,442	1.24	1,788
55-59	1,772	1.24	2,197
60-64	2,349	1.24	2,913
65-69	3,519	1.24	4,364
70-74	4,903	1.24	6,080
75-79	6,840	1.24	8,482
80-84	8,976	1.24	11,130
85-89	12,978	1.24	16,093
90-94	15,573	1.24	19,311
95+	18,738	1.24	23,235
Females			
0-4	1,623	1.24	2,013
5-9	624	1.24	774
10-14	585	1.24	725
15-19	1,111	1.24	1,378
20-24	1,638	1.24	2,031
25-29	2,022	1.24	2,507
30-34	2,005	1.24	2,486
35-39	1,646	1.24	2,041
40-44	1,262	1.24	1,565
45-49	1,403	1.24	1,740
50-54	1,551	1.24	1,923
55-59	1,773	1.24	2,199
60-64	2,199	1.24	2,727
65-69	3,123	1.24	3,873
70-74	4,219	1.24	5,232
75-79	6,303	1.24	7,816
80-84	8,985	1.24	11,141
85-89	13,735	1.24	17,031
90-94	18,944	1.24	23,491
95+	24,738	1.24	30,675

Source: Author's calculations

Step 6. Convert the health spend in step 5 from New Zealand dollars to Thai baht using the exchange rate at 1 July 2009. However, the health spend data of New Zealand provide the 95 and over as the last age group then, the estimation for health spend per capita for ages 95-99 and 100+ is made using the same data as for ages 95 and over (Table 8.7).

Table 8.7: Calculation for New Zealand per-capita health spend adjusted for 2009 price in Baht (Step 6)

Age group	New Zealand Per capita Health Spend in 2001 (price at 2001 NZ$)	2009 Constant prices, Inflator index at 2001	New Zealand Per capita Health Spend in 2001 (price at 2009 NZ$)	Exchange rate from New Zealand dollar to Thai baht at 1 July 2009	New Zealand Per capita Health Spend in 2001 (price at 2009 Baht)
Males					
0-4	1,877	1.24	2,327	20.78	48,365
5-9	723	1.24	897	20.78	18,630
10-14	658	1.24	816	20.78	16,955
15-19	843	1.24	1,045	20.78	21,722
⋮	⋮	⋮	⋮	⋮	⋮
90-94	15,573	1.24	19,311	20.78	401,273
95+	18,738	1.24	23,235	20.78	482,826
Females					
0-4	1,623	1.24	2,013	20.78	41,820
5-9	624	1.24	774	20.78	16,079
10-14	585	1.24	725	20.78	15,074
15-19	1,111	1.24	1,378	20.78	28,627
⋮	⋮	⋮	⋮	⋮	⋮
90-94	18,944	1.24	23,491	20.78	488,134
95+	24,738	1.24	30,675	20.78	637,429

Source: Author’s calculations

Step 7. Calculate the Thailand health spend for 2000 to 2005 based on the New Zealand health spend age-sex profile in 2001 by multiplying the projected population by age and sex for Thailand in 2000-2005 by the 2001 New Zealand age-sex specific per capita health expenditures (Table 8.8).

Table 8.8: Calculation of the Thailand health spend for 2000 to 2005 based on the New Zealand health spend in 2001 (Step 7) (Million)

Age group	Total Health Spend for Thailand based on New Zealand spend in 2001 (2000)	Total Health Spend for Thailand based on New Zealand spend in 2001 (2001)	Total Health Spend for Thailand based on New Zealand spend in 2001 (2002)	Total Health Spend for Thailand based on New Zealand spend in 2001 (2003)	Total Health Spend for Thailand based on New Zealand spend in 2001 (2004)	Total Health Spend for Thailand based on New Zealand spend in 2001 (2005)
Males						
0-4	120,043	119,706	119,371	119,036	118,702	118,369
5-9	50,069	49,181	48,308	47,452	46,610	45,783
10-14	45,603	45,577	45,550	45,523	45,497	45,470
15-19	59,124	58,954	58,784	58,615	58,447	58,279
⋮	⋮	⋮	⋮	⋮	⋮	⋮
90-94	3,722	4,350	5,082	5,939	6,939	8,109
95-99	746	827	917	1,017	1,127	1,250
100+	-	31	63	94	125	156
Females						
0-4	98,143	98,122	98,101	98,080	98,059	98,038
5-9	41,169	40,412	39,669	38,940	38,224	37,521
10-14	38,650	38,636	38,623	38,609	38,595	38,581
15-19	75,277	74,895	74,515	74,137	73,760	73,386
⋮	⋮	⋮	⋮	⋮	⋮	⋮
90-94	9,345	10,742	12,347	14,192	16,313	18,750
95-99	1,017	1,329	1,738	2,271	2,969	3,881
100+	-	51	102	154	205	256

Source: Author's calculations

Step 8. Calculate the health spending ratio by dividing total health spend in step 7 by the total health spend in step 3 in the same year (Table 8.9).

Step 9. Adjust the spending for Thailand age-sex groups based on New Zealand age-sex specific spend per capita by multiplying the health spend from step 7 with the health spending ratio obtained from step 8 (Table 8.9).

Step 10. Divide the Thailand health spends in step 9 by the number of population in each age group in each year to obtain the per capita health spend for Thailand (Table 8.10).

Table 8.9: Calculation of the Thailand health spend for 2000 to 2005 based on the New Zealand health spend profile in 2001 (Steps 8 and 9) (Million)

Age group	Total Health Spend for Thailand (2000)	Total Health Spend for Thailand (2001)	Total Health Spend for Thailand (2002)	Total Health Spend for Thailand (2003)	Total Health Spend for Thailand (2004)	Total Health Spend for Thailand (2005)
Health Spend Ratio	0.16	0.16	0.16	0.18	0.18	0.19
Males						
0-4	18,834	19,378	19,394	20,854	21,416	22,684
5-9	7,856	7,961	7,848	8,313	8,409	8,774
10-14	7,155	7,378	7,400	7,975	8,208	8,714
15-19	9,276	9,543	9,550	10,269	10,545	11,169
⋮	⋮	⋮	⋮	⋮	⋮	⋮
90-94	584	704	826	1,040	1,252	1,554
95-99	117	134	149	178	203	239
100+	0	5	10	16	23	30
Females						
0-4	15,398	15,884	15,938	17,183	17,692	18,788
5-9	6,459	6,542	6,445	6,822	6,896	7,190
10-14	6,064	6,254	6,275	6,764	6,963	7,394
15-19	11,811	12,124	12,106	12,988	13,308	14,064
⋮	⋮	⋮	⋮	⋮	⋮	⋮
90-94	1,466	1,739	2,006	2,486	2,943	3,593
95-99	160	215	282	398	536	744
100+	0	8	17	27	37	49

Source: Author’s calculations

Step 11. Annual percentage rate change of per capita spend in 2000 to 2005 (Table 8.10), ARC, is given by

$$ARC_{2000\text{-}2005} = ((HS_{2005}/HS_{2000})^{1/5} -1))*100 \qquad (8.4)$$

where: HS_{2005} is the per capita health spend in 2005.

HS_{2000} is the per capita health spend in 2000.

This annual percentage rate change of per capita spend is the rate which taken into account the inflation rate already.

Table 8.10: Calculation and Extrapolation the Thailand health spend for 2000 to 2050 based on the New Zealand health spend profile in 2001 (Step 10 to 13) (Baht)

Age group	Annual rate of change of per capita spend	Annual average per capita spend	Extrapolated annual average per capita spend									
	2000-5	2000-5	2005-10	2010-15	2015-20	2020-25	2025-30	2030-35	2035-40	2040-45	2045-50	2050-55
Males												
0-4	4.1	8,284	10,118	12,359	15,096	18,438	22,522	27,509	33,601	41,042	50,130	61,231
5-9	4.1	3,191	3,897	4,760	5,815	7,102	8,675	10,596	12,943	15,809	19,310	23,586
10-14	4.1	2,904	3,547	4,332	5,292	6,464	7,895	9,644	11,779	14,387	17,574	21,465
15-19	4.1	3,720	4,544	5,551	6,780	8,281	10,115	12,355	15,091	18,433	22,514	27,500
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
90-94	4.1	68,728	83,947	102,537	125,244	152,979	186,856	228,235	278,777	340,511	415,917	508,021
95-99	4.1	82,696	101,008	123,377	150,698	184,070	224,832	274,620	335,434	409,716	500,446	611,269
100+	4.3	81,918	101,156	124,912	154,247	190,472	235,204	290,441	358,650	442,879	546,888	675,323
Females												
0-4	4.1	7,163	8,749	10,686	13,053	15,943	19,474	23,786	29,054	35,488	43,346	52,945
5-9	4.1	2,754	3,364	4,109	5,018	6,130	7,487	9,145	11,170	13,644	16,666	20,356
10-14	4.1	2,582	3,153	3,852	4,705	5,747	7,019	8,574	10,472	12,791	15,624	19,084
15-19	4.1	4,903	5,989	7,315	8,935	10,914	13,331	16,283	19,888	24,293	29,672	36,243
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
90-94	4.1	83,605	102,119	124,733	152,355	186,093	227,303	277,639	339,122	414,220	505,948	617,989
95-99	4.1	109,175	133,352	162,882	198,952	243,010	296,824	362,555	442,842	540,909	660,692	807,000
100+	4.3	114,190	141,008	174,123	215,015	265,511	327,866	404,864	499,946	617,357	762,342	941,376

Source: Author’s calculations

Step 12. Calculate annual rate of per capita spend in 2000 by summing the health spend from 2000 to 2005 and dividing by 6 (Table 8.10).

Step 13. Extrapolate the health spend for the next five years (Table 8.10) by

$$HS_{2005} = HS_{2000}*((100+ARC_{2000\text{-}2005})/100)^5 \qquad (8.5)$$

To obtain trend of health expenditure for Thailand, the health spends or health expenditure per capita by gender and age group which were estimated from the calculation above are applied. The assumptions are based on the population growth and price of health spend. There are three scenarios are applied to project trends in health expenditure for Thailand between 2000 and 2050.

Scenario 1: *Population Ageing and Health Cost Constant*

The population growth rate is obtained from the author’s most likely population projection for Thailand 2000-2050 (Chapter 7). The price of health spend is constant for the whole period based on the price in 2000-2005 in Table 8.10. This scenario aims to investigate the impacts of population ageing on trends in health expenditure for Thailand

Scenario 2: Constant Population and Health Cost Growth

The population is constant at the number of population in 2005-2010 which obtained from the author most likely population projection for Thailand 2000-2050 (Chapter 7). The price of health spend is assumed to increase by 2 percent for every 5 years. This rate of change is not the real change obtained from the historical estimates. This scenario aims to investigate the impacts of growth of per capita spend on trends in health expenditure for Thailand

Scenario 3: *Population Ageing and Health Cost Growth*

The population growth rate is obtained from the author's most likely population projection for Thailand 2000-2050 (Chapter 7). The cost of per capita health spend is increased by 2 percent for every 5 years. This scenario aims to investigate the impacts of population ageing and growth of per capita spend on trends in health expenditure for Thailand

The results based on these three scenarios are presented in Figure 8.7. According to scenario 1, the health expenditures for population aged 60+ in 2025 and 2050 are projected to be much higher than the health expenditure in 2000 both for male and female. They increase more than double for age 60+ and tend to be higher when the population gets older. Health expenditure in 2050 for population aged 75-79 male and 85-89 female is expected to be the highest cost and then health expenditure tends to decline after these ages. The result also shows that health expenditure in older old age will be higher than health expenditure in younger old age group especially in 2050. The increase trend of the health spend in scenario 1 is the impact of ageing in Thailand during that period.

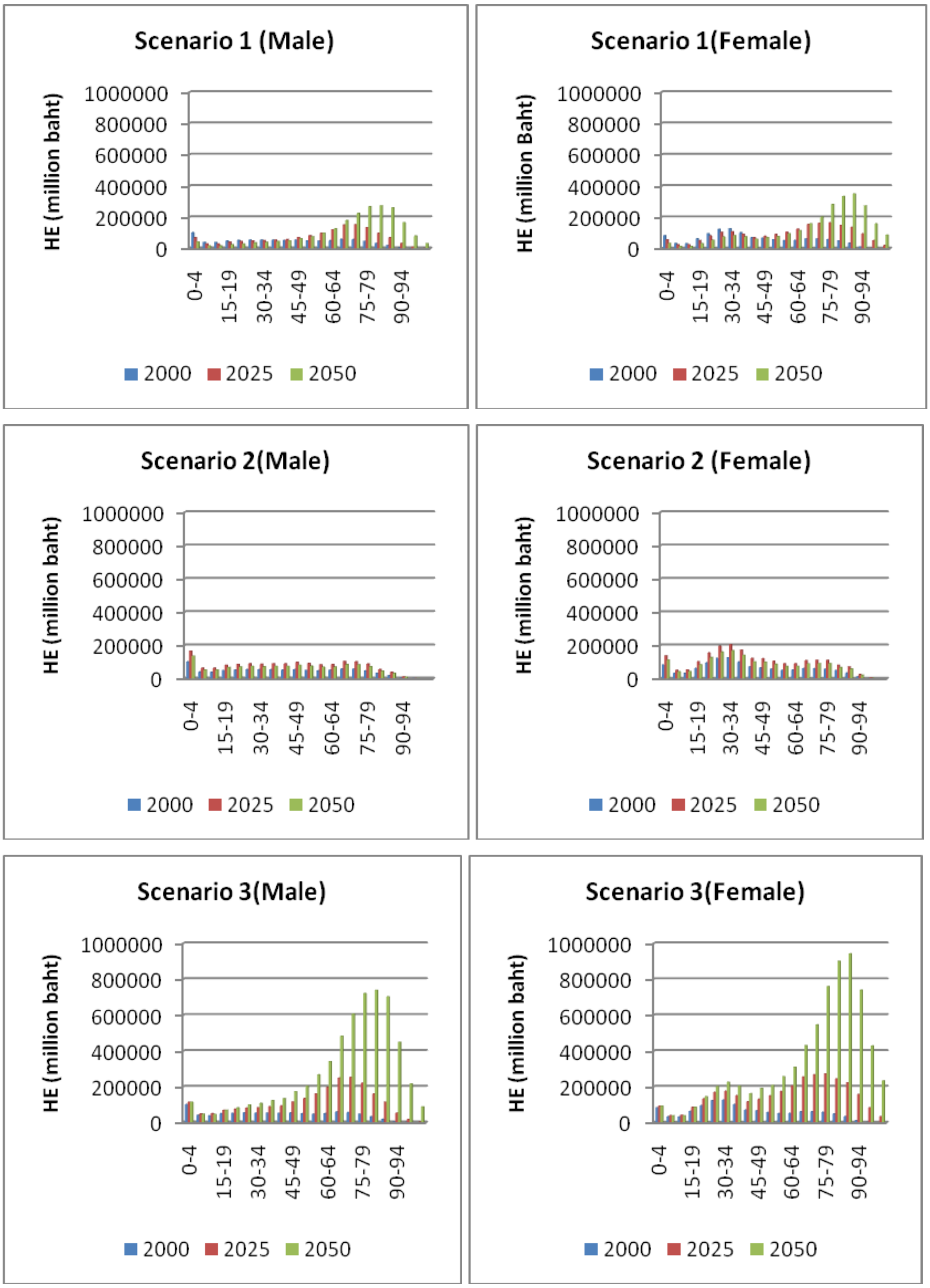


Figure 8.7 Trends in health expenditure for male and female
Source: Computation from author's Thailand population projection 2000 to 2050 (Chapter 7)

The results from scenario 2 shows that when health spend is allowed to increase, but the population was constant for the whole projection, health expenditures for males will increase a little and not differ much between age groups except in population aged 90 and over. Health expenditures for females based on the growth of health spend show that the trends of health spend in old age are projected to be lower than in the young age. The health spend in females are projected to be higher than men in the same age group. When we compare the results between scenario 2 and scenario 1, the impact of increasing price in health spend are less than the impact from population ageing. The health expenditure for males aged 0-4 and female aged 30-34 are projected to be the highest in 2050. The results also show the different health spends between females and males: old age men are projected to spend less than women.

The results from scenario 3 show that when the population is ageing and the health spend is allowed to increase the health expenditures in 2025 and 2050 are projected to increase much more than the first two scenarios particularly health expenditure in old age. This reflects to the impacts of the huge increase in the number of people in old age during the projection period and the rising price of health spends in old age.

Based on these results, the impact of population ageing on health expenditure is presented. The increase of elderly people will lead to an increase of health expenditure. Moreover, the high proportion of elderly women also affects health expenditure in old age because elderly women tend to live longer but with more disability than men. The per capita cost of health spends also affects health expenditure but its impact is less than the impact from population ageing.

The results show that the increase of population ageing in Thailand will have an impact on health expenditure particularly in the older ages. While these age groups tend to have low income and limited family support, the cost of living especially health care increased. This population need more attention both from government and private sectors to ensure that the elderly have a good quality of life. Moreover, health spends as a percentage of GDP are also increased.

8.6 Policies on Population Ageing in Thailand and Plan for Future

The first provision for older persons in Thailand was the Government Welfare Institution for the Elderly, which was established in 1953 (United Nations 2007b). However, there were no formal national policies on ageing until 1986. The First World Assembly on Ageing held in Vienna in 1982 proposed several plans for action (United Nations 1983). The Thai Government responded by setting up The National Committee for the Elderly with the Ministry of Interior providing its chair person. In 1986, the *First National Long-term Plan for Older Persons (1986-2001)* was formulated by the National Committee for the Elderly. It was a long-term plan that provided a unified approach for developing guidelines and policy for the elderly (NESDB 2002). The main objectives of this first national plan were:

- To provide older people with general knowledge on the changes associated with age and the necessary environmental adjustments (including health care).
- To provide the elderly with the protection and support of families, communities and society, including the provision of welfare services where necessary.
- To support the role of older people in participation in family and other activities.
- To emphasize society is responsibility for older people.

The implementation strategies involved health, education, income and employment, social and cultural policies.

In 1999 a "Declaration on Thailand's older persons" was announced during the United Nations International year of Older Persons. The declaration emphasized government policy on caring for the elderly; emphasising the provision of basic necessities for pursuing happy life within families, communities and societies. The new government policy also aimed to improve quality of life for older persons, as well as to encourage and empower them to participate in social activities, and also provide access to social welfare services.

The Thai government responded to the *Madrid International Plan of Action on Ageing* (United Nations 2002) by formulating the *2nd National Plan for Older Persons (2002-2021)* as a master plan for dealing with issues relating to aging population. It identified an integrated strategic framework for development and protection of the elderly and closely mirrored the development goals for older persons in corporate within the Madrid International Plan of Action on Ageing 2002 (NESDB 2002). The second Thai national plan laid out an implementation plan with five objectives:

- preparation for quality ageing
- promotion of well-being for the elderly
- provision of social security
- creation of management systems and the development expert personnel at the national level
- creation of any programme of policy research and development on the elderly; monitoring and evaluation of the *2nd National Plan for Older Persons.*

Based on these plans and the consequences of population ageing in Thailand as discussed above, the policy on population ageing which responds to this change should include the following.

1. The first measure is to reduce the gap between income and spending due to population ageing. The increase of population in old age means the non-economically active population tends to increase, particularly in Thailand where the formal retirement age is as low as 60. The older population in Thailand are themselves ageing. Moreover, the increase of the number and proportion of elderly people leads to the rise of health care expenditure especially the increase of oldest old and elderly women who have high proportions of disability. A measure to extend the retirement age needs to be considered for Thailand to help older people to have a more sufficient income during their longer life. However, our results on healthy life expectancy in old age in Thailand show that population is living longer but more years of life in disability or poor health. Increasing years of life spent in labour force in old age might be possible if their health in old age is improved.

2. Maintaining the family support for elderly population is vital as in Thailand the family is the key source of support for old people both for income and care. However, due to the impact of change in population structure and family size in Thailand, family support might decline in future as shown by the increase of the parent support ratio. The proportion of the older population who live alone has also increased. The Thai government has encouraged working age adults to take care of their old parents by granting entitlement to tax exemptions up to a specified maximum based on their income.

3. The third measure is to develop and improve the pension schemes and welfare benefits for old people. As population ageing tends to affect the increase in health expenditure while the income and family support will decline. To ensure that population in old age has sufficient income for their living the state pension scheme will be developed. In Thailand, the pension scheme is limited to employees of state or public enterprises. The coverage of the pension scheme will be improved. The value of the old age pension needs to be sufficient for the basic living costs of the elderly.

Following the inclusion in the Constitution (1997) of the provision that the elderly (60+) with insufficient income have the right to receive aid from the state, the Thai government provide social welfare assistance of 300 baht (approximately 6 GBP) per month to older persons having an annual income less than 10,000 baht. However, the amount is so low, and consideration should be given to increasing the benefit.

4. The 30 baht Universal Health Care Scheme was established in Thailand to help in reducing the burden on health care cost for elderly and family. Health care services need to be expanded as demand for health care is rising. The Ministry of Public Health encourages community hospitals to run elderly clinics and to provide home health services by visiting older persons in their homes. The promotion of healthy behaviour will be help to reduce the demand for health care services and long term care.

The change in the population age structure in Thailand has required the government to re-examine existing policy (and its implementation) carefully and design new practical policies to provide improved protection for the elderly. To raise awareness of the challenges of population ageing, the government has targeted the integration of ageing issues into the mainstream of national development. *The 10th National Economic and Social Development Plan (2007-2011)* has been formulated as a comprehensive development plan with one of its aims to prepare Thai society for population ageing. This has provided an opportunity to push forward ageing issues within the national development agenda.

8.7 Discussion and Conclusions

The population aged 60+ in Thailand has increased both in terms of numbers and proportions compared with the other age groups. Moreover, this older population is itself ageing due to the increasing proportion of the 60+ who are population aged 80+. Thailand now not only faces population ageing but also the ageing of old population. The elderly women are dominant in the elderly population of Thailand and this will continue in the future. Population ageing leads to consequences for socioeconomic support, health care service and health expenditure. The impact of population ageing on the socioeconomic support is measured by the increasing old age dependency ratio, which means the increase of old population will also increase the economically inactive population who needs income support. The other socioeconomic consequence of population ageing is the increase of the parental support ratio. The number of old parent tends to increase while the number of children tends to decline due to the low fertility.

The main consequence for health care services result from the increase in disability in old age. The increase in the number of elderly population particularly the oldest old and elderly women who are more frails, leads to increased demand for health care, especially long term care. When health care demand increases, it also affects health expenditure in old age. Health expenditure in Thailand tends to increase particularly as a percentage of GDP. These developments create challenges for Thailand in term of policy and measures that need to be applied. Thailand has developed the National Plan for older persons, which is based on the global and regional initiatives on population ageing. The key policies and measures to respond to population ageing should include increase in the working age, increase in health care services and facilities, promotion and maintenance of family support for old age and the promotion of healthy behaviour. If the health status of the elderly improves this will reduce the demand for health care and enable people to work longer.

CHAPTER 9:
CONCLUSIONS

9.1 Introduction

This chapter provides a discussion of the results from the previous chapters cross-referenced against the aims and objectives of this research as presented in Chapter 1. This chapter starts in Section 9.2 with a summary of key findings to evaluate how far the aim and objectives have been achieved. The limitations of this study are explored in Section 9.3 and then follow the final section that reflects on the potential for future research.

9.2 Summary of the Research Findings

The aim of this research as stated in Chapter 1 was "to investigate the variations in health status of elderly in Thailand and health trends in the future". To fulfil this aim, the set of objectives as outlined in Section 1.2 needed to be achieved. This section then presents the achievement of the objectives by referring to key findings of each chapter.

Objective 1: To review the health theories, health measurement, health indicators and factors affecting health in old age

This objective is adopted as a target for Chapter 2. The health theories of old age are divided into three groups including the morbidity (disability) expansion, morbidity compression and dynamic equilibrium. These theories try to define whether or not the increase in life expectancy is accompanied by an increase of life with poor health. To investigate health trends in old age, healthy life expectancy was introduced. It divides total life expectancy into life in good health (or free from disability) and life in poor health (or lived with disability). However, trends in healthy life expectancy can vary depending on health indicators applied. Most health researchers of old age employed self-rated health to indicate the general health status whereas the limitation on activities in daily living (ADLs) was used to measure the disability in later life. However, different studies tend to use different health indicators so that precise comparison between these studies was limited. A universally applicable and standardised set of questions need to be adopted so that comparable health variations can be employed for calculating healthy life expectancy. There was substantial evidence that health in old age varied by age, gender, education, living arrangement and economic status.

Objective 2: To review population ageing in Thailand and the health status of old age Thai

Population ageing in Thailand was reviewed in Chapter 3. Key factors producing population ageing in Thailand were the continuing decline in fertility and mortality, particularly the decrease of mortality in later life. The studies of old age Thai showed increase in both absolute and relative numbers. The oldest old who are aged 80 and over and elderly women were the most rapidly increasing group. These increases lead to concern about poorer health in old age due to these population groups being more frails. Healthy life expectancy based on self-rated disability and disability in activities of daily living was investigated for old age Thai in 1996-1997 (Jitapunkul et al. 1999, Jitapunkul et al. 1993). The results shown that the proportion of life lived with long-term disability and self-care disability increased with age and old age women were more likely to spend their lives with disability than men in all age groups. However, because of data limitations, it was not possible to determine trends in healthy life expectancy in old age.

Objective 3: To review and investigate the available data and methods for measuring variations in health of elderly in Thailand

The review in Chapter 2 concluded that health status and health trends varied considerably between places, times and health indicators. The investigation of variations in health of the elderly is important for future planning, especially for developing health policy and the health system. In order to achieve Objective 3, Chapter 4 reviewed the data available for measuring variations in health and also reviewed what methods should be employed. The Surveys of Elderly in Thailand

2002 and 2007 were the key sources of old age health variables. The surveys measured health status in terms of self-rated health and disability in daily living which included self-care activities and mobility activities. These health indicators have been used in various studies of elderly health. The health prevalence rates obtained from these two surveys were modelled using multilevel modelling that allows health status to vary simultaneously between individuals and places. The variations in health due to the differences in individual characteristics and differences in areas of residence were explored in Chapter 5. The health prevalence rates from the surveys were combined with Thailand life tables to calculate healthy life expectancy in Chapter 6, Sections 6.6 and 6.7. Two methods for calculating healthy life expectancy have been used: The Sullivan method and the multistate method. The Sullivan method was used in this study because only health status prevalence rates were available. The state to state transition rates or probabilities needed for the multistate method were not available in Thailand. The variations in healthy life expectancy were investigated in Chapter 6. The methods used to project the health status of the population were reviewed in this chapter. The method provided the ability to project trends of health in the future and also the future numbers of people in different health statuses. The changes in the number of people in various health states depended on the future assumptions about the population components and assumptions about changes in health trends. The results of the health projections were presented in Chapter 7.

Objective 4: To explore the relationship between demographic characteristics, socio-economic characteristics, living arrangement and health status

This objective was achieved in Chapter 5. Multilevel models were employed to explore the relationship between individual characteristics and health status, taking into account the differences between places. The health states were measured in terms of self-care activities and mobility activities and the individual characteristics included age, gender, education, living arrangement, working status and housing tenure. The multilevel modelling showed that all of these individual characteristics except gender were statistically significant in determining the level of self-care activities using Wald-test. The fixed effects of mobility activities were shown to have statistically significant relationships for all individual variables. Based on the estimates of the fixed effects of the multilevel model for self-care and mobility activities, the older population was more likely to have lower levels of self-care and mobility activities than younger population. Elderly men had a lower level of self-care activities but a higher level of mobility compared with women, controlling for other variables. Higher levels of education and economic status both improved the level of self-care and mobility activities.

Objective 5: To apply multilevel modelling in determining the geographical variations in health status of elderly Thai.

This objective was fulfilled in Chapter 5. Multilevel models were used to model the variations in health between places. The variations in self-care and mobility between provinces and local residences areas (Primary Sampling Units, PSUs) were modelled. The amounts of variation in health between areas of residences (places) were found in the random effects model. The estimates of random effects at province level and for local residence areas were all statistically significant for both the self-care model and the mobility model. However, the amounts of variation between provinces were smaller than between PSUs. Moreover, the differences between geographical areas of the relationship between age and level of self-care and mobility activities were investigated using the random slope models. The results showed no variations between provinces and PSUs in the relationship between age and level of self-care activities. But the variations between PSUs in the relationship between age and level of mobility were statistically significant although there were no variations between provinces.

Objective 6: To explore the life expectancy, health status and its variations by calculating Thailand life tables and healthy life expectancy

Chapter 6 focused on the investigation of healthy life expectancy in 2002 and 2007 as set out in Objective 6. The Sullivan method for calculating healthy life expectancy was adopted because the health data were available as prevalence rates. The calculation based on this method contains two parts. First is the construction of life tables to measure the total life expectancy. The period life tables for Thailand were constructed based on the number of deaths and mid-year population obtained from

Thailand Vital Registration. The outcomes showed that the life expectancy for Thai population had improved in recent years in all age groups, particularly in the old age population and in both males and females (Chapter 6, Section 6.4), as found from the other sources (UNFPA 2006a, Ministry of Public Health 2008). The life expectancy at age 60 in 2002 was 19.4 for males and 21.1 for females whereas in 2007 these had increased to 20.2 for males and 22.8 for females. Old age females were estimated to live longer than males. The second part of healthy life expectancy calculation involved computation of health prevalence rates from the Survey of Elderly in Thailand in 2002 and 2007. These prevalence rates were classified into three groups including self-rated health, self-care disability and mobility disability as distinguished in the literature review in Chapter 2. The prevalence of self-rated poor health increased in population aged 60-64 from 36.8 percent for males in 2002 to 39.9 percent in 2007 and decreased for the older old population, aged 80+ between 2002 and 2007. The prevalence rate of poor health for males aged 90-94 was 78.2 percent in 2002 and decreased to 75.2 percent in 2007. The prevalence of self-care disability tended to increase in the old age population for all age groups and both males and females. The prevalence of mobility disability improved in the young old ages and in old age females. The mobility disability prevalence for elderly female aged 60-64 was 33.9 percent in 2002 and reduced to 22.2 percent in 2007. However, the mobility prevalence rates tend to increase at elderly ages 85+.

Because health prevalence came from two points of time, then variations in healthy life expectancy between 2002 and 2007 by age and gender were investigated. The variations in healthy life expectancy calculated from self-rated health showed the improvement as found in the total life expectancy (Chapter 6, Section 6.7). When compared the proportion of life lived in good health between 2002 and 2007, the proportion in good health reduced in the population aged 60-79 and the proportion increased in oldest old aged 80+. The proportion of males aged 60-64 in good health reduced from 48.3 percent in 2002 to 46.0 percent in 2007, whereas for elderly males aged 85-89, the proportion in good health rose from 25.5 to 27.1. This implies that at younger ages 60-79, the improvement in their life expectancy was greater than the improvement in their healthy life expectancy. This supports the morbidity expansion hypothesis while the reverse trend was found for oldest old at which morbidity compression occurred. The self-care disability free life expectancy and mobility free life expectancy showed the same improvement trends as found in self-rated health. But the improvement in life free from self-care disability was lower than the improvement in total life expectancy so that, the disability expansion hypothesis was supported. However, the results of changes in percentage of life lived free from mobility disability to total life expectancy confirmed the disability compression in old age Thai between 2002 and 2007. The comparison of results from this research with other research was limited because the differences in health indicators applied. Based on these key findings, trends in health in old age varied depend on the health indicators applied. Furthermore, these results came from only two points in time that might not enough to represent definite changes in health. The changes might reflect some random fluctuations. Differences in prevalence rates between the two surveys were not, in general, statistically significant.

Objective 7: To project the numbers of elderly in Thailand and their health trends.

This objective was attained in Chapter 7. The population studies in Thailand showed the increase in numbers and proportions of population aged 60 and over as stated in Chapter 3. This chapter then estimated and projected the numbers and proportion of elderly Thai from 2000 to 2050 to explore how the number and proportion of elderly change over this period. In order to develop the new set of population projection, the recent population projection produced by United Nations (2005-2050) and The National Economic and Social Development Board (NESDB) were reviewed and reproduced to understand their methods and assumptions. The cohort component method, which projects population based on assumptions of change in three components (fertility, mortality and migration), was adopted for population projection. The fertility assumption was set as total fertility decline, whereas mortality assumption was set as life expectancy at birth steadily improving and the migration assumption was a constant assumption for the whole projection period. The projected population showed the continuing increase in numbers of people aged 60 and over and that their proportion in total population will rise. The oldest old and the old age women will increase most, of all age groups, in the next 50 years.

This chapter also extended the population projection to project the numbers and proportion of the population by different disability states. The assumptions of change in disability were 2 percent decrease per 5 years, 2 percent increase per 5 years and constant prevalence rates.

The constant assumption shows the pure effect of ageing on the future health status. Based on the constant assumption projection in Chapter 7, Section 7.7, the number of self-care disabled population is projected to increase for the whole projection period even when the prevalence rates of disability are assumed to be constant. The proportions of self-care disabled population aged 60 and over are projected to nearly double from 2.8 percent to 4.8 percent for males and from 3.4 percent to 6.9 percent for females between 2000 and 2050. The proportion of elderly women who lived with self-care disability will be more than men in all age group particularly in people aged 80 and over. This is because the elderly women are projected to live longer than men but with higher disability prevalence rates. The results for projecting population with mobility disability show the same trend that the number of disabled elderly will increase in the next 50 years even when the mobility disability is held constant. The number of older women who lived with mobility disability was projected to be more than number of men, as occurred in the self-care disability projection.

The assumption of prevalence rates increased 2 percent shows the effect of ageing and the increasing trends of disability. The projection results in Chapter 7, Section 7.7 show the increase in proportion of old people aged 60 and over who are disabled in self-care activities will double between 2000 and 2050 both for males and females. The proportions of females aged 80 and over are expected to increase from 12 percent in 2000 to reach 20 percent in 2050. Whereas nearly 90 percent of older old people aged 80+ was expected to be mobility disabled in 2050. This huge increase of disabled old age population is because the huge increase in number of elderly in Thailand in next 50 years particularly older old women aged 80+ who have a high proportion of disability.

The number of elderly people who lived with disability was projected to increase even the disability rated was allowed to decline 2 percent per 5 years. This stresses the effects of ageing in Thailand in the next 50 year. However, this scenario shows decreases in the number and proportion of old age with disability compared with the constant disability prevalence rates assumption.

We concluded that the number of elderly Thai will increase in the future and the number of elderly with disability was projected to increase even when the current disability prevalence was constant or decreased.

Objective 8: To investigate consequences of ageing and variations in health in old age on health expenditure, the health system and health policy

This objective was examined in Chapter 8 which explored the consequences of ageing. Health expenditure was calculated and projected to 2050 as one of the key consequences of population ageing in Thailand. The health expenditure projection was calculated by combining the projected old age population obtained from Chapter 7 with the estimated health spend by age and sex. There were two scenarios were developed to investigate the impacts of population ageing and variations in health on health expenditure in old age. Both the constant price scenario and price increase 2 percent scenario showed the growth in health expenditure for males and females. However, the health expenditure was projected to increase rapidly at age 70 and over and old age females were projected to spend much more than males on health treatment. These confirm that change in numbers of old age and their health have affected the growth of health expenditure.

Health system and health policy responses to population ageing and health variations need to promote healthy ageing to reduce future health expenditure. Moreover, the working life time might need to extend to reducing the gap between their health spend and income. Health care schemes, pension schemes and family support were the important factors to cope with the growth of the demand for health care in Thailand. The state pension scheme need to be expanded to cover all of population or most of them due to it currently benefit only the population who are employees of state or public enterprises as reviewed in Chapter 8, Section 8.6. The pension needs to meet their needs for spending in later life which is projected to rise in the future. It will be important to improve the state health care scheme for older people. Family support will still be the main source of health care and income in elderly Thai, but family capacity will diminish because the numbers of children will reduce as fertility rates are low and expected to be very low in the future.

Objective 9: To evaluate the key findings and limitations of this research and provide the recommendations for future work

This objective is fulfilled in Chapter 9, this chapter. The key findings of each chapter have been discussed, along with an evaluation of whether or not the aim and objectives of this research were achieved. Moreover, in the following sections, the limitations of this research and the recommendation for future works will be outlined.

Overall the results have shown that there are variations in the health of elderly in Thailand. The variations are found by geographical areas, by time, by health indicators and by individual characteristics.

9.3 Limitations of the research

Although the aim and objectives of this study have been achieved, it was necessary to introduce many assumptions due to the limitation of data. Further research is needed to substitute error estimates for these assumptions.

Studying health variations by geographical areas using multilevel models in Chapter 5 will be more useful for health policy or health monitoring if the Primary Sampling Units (PSUs) could be known where it is because the variations in health between geographical areas were all statistically significant. In this study PSUs could not be identified because of the need for patient confidentiality. What might be provided in future, through collaboration between researcher and Thailand National Statistical Office (NSO), is a set of classification of PSUs (rural/urban; poor/rich; stable/with conflict) which might affect life expectancy and health.

Healthy life expectancy is applied as the key health measurement for old age but the health indicators used in the calculation are far from universal. For this study there were three indicators applied because the study wanted to put Thailand in the global context and to compare current results with the previous study in Thailand. However, differences in question wording and definition of activities lead to limitation in comparing the results with those of other studies.

There are two methods for calculating healthy life expectancy but because of health of old age Thai was measured in prevalence rates then in this study only the Sullivan method was employed for calculating healthy life expectancy. If data on health are available as transitions between health states, healthy life expectancy can be calculated using the multistate method that provides the ability to compare the results between two different methods. A longitudinal elderly health study should be considered for Thailand.

To improve the computation of healthy life expectancy for Thailand, a better time series of life tables is also important. The number of deaths and mid-year population from vital registration as used for life table calculation were reported to age 70 and over. The last age should be disaggregated into five years ages to 100+ to match current international series. The estimation used in the current work might produce errors in the results.

This study estimated trends in healthy life expectancy based on the change between two points in time. The disability projection based on this change then provided unreliable trends. A longer time series of disability prevalence rates is then needed to improve the health projection. However, the questions used in the future surveys should keep in the same wording as in 2002 and 2007 to make them useful for exploring trends.

The migration flow data which are needed for population projection by cohort component method are lacking. Then if this data became available, the population projection for Thailand will be more accurate.

Trends in health expenditure as investigated in Chapter 8 reflect that the increase in number of old age and variations in health of this population affected the health expenditure in later life. These trends in health expenditure for Thailand were estimated based on costs in New Zealand. The results therefore were only crude estimates. To improve these results the costs of health expenditure by age and sex for Thai population should be investigated.

9.4 Future Research

This research investigated the variations in health of elderly Thai in various ways and using different health indicators. The potential for further investigation and extending this research are as follows.

The study of variations in health between different geographical areas using the multilevel models could be extended to investigate the variations between other geographical areas such as the districts or sub-districts if the data were available.

It is important to continue to investigate the healthy life expectancy for old age Thai in the future, particularly the calculation based on the next survey of elderly in Thailand. The results will help in projecting trends in old age health and also improve the health status projections for the future. It is very important for policy makers to know the future numbers of old people and their health states. The calculation for healthy life expectancy for Thailand using the multistate method will be useful for providing insights into the changes in health of old age Thai because it allows the transition between health states.

Recent work by Sanderson and Scherbov (2010) points the way forwards to harmonized analysis of future populations classified by disability status. Using the European Union Statistics on Income and Living Conditions (EU-SILC) survey they were able to harmonize the definition of disability and develop a methodology for forecasting disability rates based on the relationship between disability prevalence rates and mortality incidence rates. When coupled with a shift in definition of the dependent population to a dynamic measure of those with only 15 years of life remaining, they conclude that the future challenge of ageing is lower than hitherto assessed. It would be very interesting to apply their approach to the Thai population.

The study of prices in health expenditure in old age by age and sex will be key information for improving the projection of health expenditure for Thailand.

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Appendix A
Healthy Life Expectancy, Thailand 2002 and 2007

Table A.1: Self-rated healthy life expectancy 2002, Thailand

Age	Number of surviving to age x	Person years lived in age interval between age x to x+n	Total numbers of years lived from age x	Total life expectancy	Proportion with poor health	Proportion with good health	Person years lived with good health in age interval	Total years lived with good health from age x	Good health life expectancy	Percent of life spent in good health
x	l_x	$_nL_x$	T_x	e_x	$_nPH_x$	$_nGH_x$	$(_nGH_x)_nL_x$	$\Sigma(_nGH_x)_nL_x$	$GHLE_x$	$GHLE_x/e_x$
Males										
0	100000	99497	6940040	69.4	0.045189	0.954811	95001	5461464	54.6	78.7
1	99281	396162	6840543	68.9	0.049100	0.950900	376710	5366464	54.1	78.5
5	98799	493072	6444381	65.2	0.057012	0.942988	464961	4989753	50.5	77.4
10	98429	491371	5951309	60.5	0.067307	0.932693	458299	4524792	46.0	76.0
15	98119	488251	5459938	55.6	0.079460	0.920540	449455	4066494	41.4	74.5
20	97181	482720	4971687	51.2	0.093809	0.906191	437437	3617039	37.2	72.8
25	95907	474621	4488967	46.8	0.110748	0.889252	422058	3179602	33.2	70.8
30	93942	463257	4014345	42.7	0.130746	0.869254	402688	2757544	29.4	68.7
35	91361	450502	3551089	38.9	0.154355	0.845645	380965	2354857	25.8	66.3
40	88840	437684	3100587	34.9	0.182227	0.817773	357926	1973892	22.2	63.7
45	86234	423785	2662902	30.9	0.215132	0.784868	332615	1615965	18.7	60.7
50	83280	407059	2239117	26.9	0.235000	0.765000	311400	1283350	15.4	57.3
55	79543	385523	1832058	23.0	0.290000	0.710000	273721	971950	12.2	53.1
60	74666	358433	1446535	19.4	0.368000	0.632000	226530	698229	9.4	48.3
65	68708	323969	1088102	15.8	0.440000	0.560000	181422	471699	6.9	43.4
70	60880	276550	764134	12.6	0.541000	0.459000	126936	290277	4.8	38.0
75	49740	215769	487584	9.8	0.600000	0.400000	86308	163340	3.3	33.5
80	36567	147634	271815	7.4	0.693000	0.307000	45324	77033	2.1	28.3
85	22486	82227	124181	5.5	0.728000	0.272000	22366	31709	1.4	25.5
90	10405	33389	41954	4.0	0.782000	0.218000	7279	9343	0.9	22.3
95	2951	8034	8565	2.9	0.743000	0.257000	2065	2065	0.7	24.1
Females										
0	100000	99569	7538572	75.4	0.110173	0.889827	88599	5084862	50.8	67.5
1	99384	396664	7439004	74.9	0.116819	0.883181	350327	4996264	50.3	67.2
5	98948	493973	7042339	71.2	0.129808	0.870192	429851	4645937	47.0	66.0
10	98641	492678	6548367	66.4	0.145941	0.854059	420776	4216086	42.7	64.4
15	98430	491416	6055689	61.5	0.164079	0.835921	410785	3795310	38.6	62.7
20	98136	489412	5564273	56.7	0.184472	0.815528	399129	3384525	34.5	60.8
25	97629	485526	5074861	52.0	0.207399	0.792601	384828	2985397	30.6	58.8
30	96582	480199	4589336	47.5	0.233176	0.766824	368228	2600568	26.9	56.7
35	95498	474940	4109137	43.0	0.262156	0.737844	350432	2232341	23.4	54.3
40	94478	469420	3634197	38.5	0.294738	0.705262	331064	1881909	19.9	51.8
45	93290	462440	3164777	33.9	0.331370	0.668630	309201	1550845	16.6	49.0
50	91686	452648	2702337	29.5	0.343000	0.657000	297390	1241644	13.5	45.9
55	89373	438526	2249689	25.2	0.403000	0.597000	261800	944254	10.6	42.0
60	86038	419088	1811163	21.1	0.505000	0.495000	207449	682454	7.9	37.7
65	81598	392010	1392075	17.1	0.557000	0.443000	173661	475005	5.8	34.1
70	75206	347760	1000065	13.3	0.633000	0.367000	127628	301345	4.0	30.1
75	63897	281722	652305	10.2	0.693000	0.307000	86489	173717	2.7	26.6
80	48791	199328	370583	7.6	0.755000	0.245000	48835	87228	1.8	23.5
85	30940	113582	171256	5.5	0.766000	0.234000	26578	38393	1.2	22.4
90	14493	46264	57674	4.0	0.785000	0.215000	9947	11815	0.8	20.5
95	4012	10799	11410	2.8	0.827000	0.173000	1868	1868	0.5	16.4

Table A.2: Self-rated healthy life expectancy 2007, Thailand

Age	Number of surviving to age x	Person years lived in age interval between age x to x+n	Total numbers of years lived from age x	Total life expectancy	Proportion with poor health	Proportion with good health	Person years lived with good health in age interval	Total years lived with good health from age x	Good health life expectancy	Percent of life spent in good health
x	l_x	$_nL_x$	T_x	e_x	$_nPH_x$	$_nGH_x$	$(_nGH_x)_nL_x$	$\Sigma(_nGH_x)_nL_x$	$GHLE_x$	$GHLE_x/e_x$
Males										
0	100000	99421	7155699	71.6	0.064418	0.935582	93016	5396503	54.0	75.4
1	99173	396082	7056279	71.2	0.069237	0.930763	368659	5303487	53.5	75.2
5	98869	493682	6660196	67.4	0.078839	0.921161	454761	4934828	49.9	74.1
10	98604	492292	6166514	62.5	0.091078	0.908922	447455	4480067	45.4	72.7
15	98312	489282	5674222	57.7	0.105216	0.894784	437801	4032613	41.0	71.1
20	97400	484506	5184941	53.2	0.121550	0.878450	425614	3594811	36.9	69.3
25	96402	478989	4700435	48.8	0.140418	0.859582	411730	3169197	32.9	67.4
30	95194	472013	4221446	44.3	0.162216	0.837784	395445	2757467	29.0	65.3
35	93612	463361	3749433	40.1	0.187397	0.812603	376529	2362022	25.2	63.0
40	91733	452852	3286072	35.8	0.216488	0.783512	354815	1985494	21.6	60.4
45	89408	439627	2833220	31.7	0.250094	0.749906	329679	1630679	18.2	57.6
50	86443	423062	2393593	27.7	0.274000	0.726000	307143	1301000	15.1	54.4
55	82782	401527	1970531	23.8	0.323000	0.677000	271834	993857	12.0	50.4
60	77829	372794	1569004	20.2	0.399000	0.601000	224049	722023	9.3	46.0
65	71288	335432	1196210	16.8	0.463000	0.537000	180127	497974	7.0	41.6
70	62884	288435	860778	13.7	0.534000	0.466000	134411	317847	5.1	36.9
75	52490	231572	572342	10.9	0.630000	0.370000	85682	183436	3.5	32.1
80	40139	167598	340770	8.5	0.697000	0.303000	50782	97754	2.4	28.7
85	26900	103794	173172	6.4	0.720000	0.280000	29062	46972	1.7	27.1
90	14618	50463	69377	4.7	0.752000	0.248000	12515	17909	1.2	25.8
95	5568	16497	18914	3.4	0.673000	0.327000	5394	5394	1.0	28.5
Females										
0	100000	99529	7812340	78.1	0.116948	0.883052	87890	5165751	51.7	66.1
1	99328	396837	7712811	77.7	0.123711	0.876289	347744	5077861	51.1	65.8
5	99091	494982	7315974	73.8	0.136885	0.863115	427226	4730117	47.7	64.7
10	98902	494021	6820992	69.0	0.153175	0.846825	418349	4302891	43.5	63.1
15	98707	492878	6326971	64.1	0.171404	0.828596	408397	3884542	39.4	61.4
20	98445	491441	5834092	59.3	0.191802	0.808198	397182	3476145	35.3	59.6
25	98132	489455	5342651	54.4	0.214627	0.785373	384405	3078963	31.4	57.6
30	97650	486592	4853196	49.7	0.240169	0.759831	369728	2694558	27.6	55.5
35	96987	482959	4366605	45.0	0.268750	0.731250	353164	2324830	24.0	53.2
40	96197	478422	3883646	40.4	0.300732	0.699268	334545	1971667	20.5	50.8
45	95172	472306	3405224	35.8	0.336520	0.663480	313366	1637121	17.2	48.1
50	93751	463579	2932917	31.3	0.347000	0.653000	302717	1323756	14.1	45.1
55	91681	450598	2469338	26.9	0.412000	0.588000	264952	1021039	11.1	41.3
60	88558	431204	2018740	22.8	0.485000	0.515000	222070	756087	8.5	37.5
65	83923	403119	1587536	18.9	0.553000	0.447000	180194	534017	6.4	33.6
70	77324	363805	1184417	15.3	0.655000	0.345000	125513	353823	4.6	29.9
75	68198	309865	820612	12.0	0.684000	0.316000	97917	228310	3.3	27.8
80	55748	239204	510746	9.2	0.738000	0.262000	62671	130392	2.3	25.5
85	39933	157576	271543	6.8	0.743000	0.257000	40497	67721	1.7	24.9
90	23097	81107	113966	4.9	0.744000	0.256000	20763	27224	1.2	23.9
95	9345	28138	32859	3.5	0.785000	0.215000	6050	6460	0.7	19.7

Table A.3: Self-care disability free life expectancy 2002, Thailand

Age	Number of surviving to age x	Person years lived in age interval between age x to x+n	Total numbers of years lived from age x	Total life expectancy	Proportion with self-care disability	Proportion with self-care disability free	Person years lived free from self-care disability in age interval	Total years lived free from self-care disability from age x	Self-care disability free life expectancy	Percent of life spent free from self-care disability
x	l_x	$_nL_x$	T_x	e_x	$_nSCD_x$	$_nSCDF_x$	$(_nSCDF_x)_nL_x$	$\Sigma(_nSCDF_x)nL_x$	$SCDFLE_x$	$SCDFLE_x/e_x$
Males										
0	100000	99497	6940040	69.4	0.000081	0.999919	99489	6880164	68.8	99.1
1	99281	396162	6840543	68.9	0.000099	0.999901	396123	6780675	68.3	99.1
5	98799	493072	6444381	65.2	0.000142	0.999858	493002	6384552	64.6	99.1
10	98429	491371	5951309	60.5	0.000213	0.999787	491266	5891550	59.9	99.0
15	98119	488251	5459938	55.6	0.000319	0.999681	488095	5400284	55.0	98.9
20	97181	482720	4971687	51.2	0.000478	0.999522	482490	4912189	50.5	98.8
25	95907	474621	4488967	46.8	0.000716	0.999284	474282	4429699	46.2	98.7
30	93942	463257	4014345	42.7	0.001071	0.998929	462760	3955417	42.1	98.5
35	91361	450502	3551089	38.9	0.001604	0.998396	449780	3492657	38.2	98.4
40	88840	437684	3100587	34.9	0.002402	0.997598	436633	3042878	34.3	98.1
45	86234	423785	2662902	30.9	0.003596	0.996404	422261	2606244	30.2	97.9
50	83280	407059	2239117	26.9	0.007000	0.993000	404210	2183983	26.2	97.5
55	79543	385523	1832058	23.0	0.006000	0.994000	383209	1779773	22.4	97.1
60	74666	358433	1446535	19.4	0.011000	0.989000	354491	1396564	18.7	96.5
65	68708	323969	1088102	15.8	0.018000	0.982000	318137	1042073	15.2	95.8
70	60880	276550	764134	12.6	0.028000	0.972000	268806	723936	11.9	94.7
75	49740	215769	487584	9.8	0.043000	0.957000	206491	455130	9.2	93.3
80	36567	147634	271815	7.4	0.073000	0.927000	136857	248639	6.8	91.5
85	22486	82227	124181	5.5	0.078000	0.922000	75813	111782	5.0	90.0
90	10405	33389	41954	4.0	0.140000	0.860000	28714	35969	3.5	85.7
95	2951	8034	8565	2.9	0.143000	0.857000	6885	7255	2.5	84.7
Females										
0	100000	99569	7538572	75.4	0.000033	0.999967	99565	7447856	74.5	98.8
1	99384	396664	7439004	74.9	0.000042	0.999958	396648	7348291	73.9	98.8
5	98948	493973	7042339	71.2	0.000064	0.999936	493941	6951643	70.3	98.7
10	98641	492678	6548367	66.4	0.000102	0.999898	492627	6457702	65.5	98.6
15	98430	491416	6055689	61.5	0.000165	0.999835	491335	5965075	60.6	98.5
20	98136	489412	5564273	56.7	0.000264	0.999736	489282	5473740	55.8	98.4
25	97629	485526	5074861	52.0	0.000424	0.999576	485320	4984457	51.1	98.2
30	96582	480199	4589336	47.5	0.000682	0.999318	479871	4499138	46.6	98.0
35	95498	474940	4109137	43.0	0.001095	0.998905	474420	4019266	42.1	97.8
40	94478	469420	3634197	38.5	0.001758	0.998242	468595	3544846	37.5	97.5
45	93290	462440	3164777	33.9	0.002824	0.997176	461134	3076252	33.0	97.2
50	91686	452648	2702337	29.5	0.005000	0.995000	450385	2615117	28.5	96.8
55	89373	438526	2249689	25.2	0.008000	0.992000	435018	2164732	24.2	96.2
60	86038	419088	1811163	21.1	0.011000	0.989000	414478	1729715	20.1	95.5
65	81598	392010	1392075	17.1	0.015000	0.985000	386130	1315236	16.1	94.5
70	75206	347760	1000065	13.3	0.030000	0.970000	337327	929106	12.4	92.9
75	63897	281722	652305	10.2	0.047000	0.953000	268481	591780	9.3	90.7
80	48791	199328	370583	7.6	0.081000	0.919000	183182	323299	6.6	87.2
85	30940	113582	171256	5.5	0.137000	0.863000	98021	140117	4.5	81.8
90	14493	46264	57674	4.0	0.279000	0.721000	33356	42096	2.9	73.0
95	4012	10799	11410	2.8	0.218000	0.782000	8445	8740	2.2	76.6

Table A.4: Self-care disability free life expectancy 2007, Thailand

Age	Number of surviving to age x	Person years lived in age interval between age x to x+n	Total numbers of years lived from age x	Total life expectancy	Proportion with self-care disability	Proportion with self-care disability free	Person years lived free from self-care disability in age interval	Total years lived free from self-care disability from age x	Self-care disability free life expectancy	Percent of life spent free from self-care disability
x	l_x	${}_nL_x$	T_x	e_x	${}_nSCD_x$	${}_nSCDF_x$	$({}_nSCDF_x){}_nL_x$	$\Sigma({}_nSCDF_x)nL_x$	$SCDFLE_x$	$SCDFLE_x/e_x$
Males										
0	100000	99421	7155699	71.6	0.000105	0.999895	99410	7064094	70.6	98.7
1	99173	396082	7056279	71.2	0.000128	0.999872	396032	6964684	70.2	98.7
5	98869	493682	6660196	67.4	0.000184	0.999816	493592	6568652	66.4	98.6
10	98604	492292	6166514	62.5	0.000275	0.999725	492156	6075060	61.6	98.5
15	98312	489282	5674222	57.7	0.000412	0.999588	489080	5582904	56.8	98.4
20	97400	484506	5184941	53.2	0.000617	0.999383	484207	5093825	52.3	98.2
25	96402	478989	4700435	48.8	0.000924	0.999076	478546	4609618	47.8	98.1
30	95194	472013	4221446	44.3	0.001382	0.998618	471360	4131071	43.4	97.9
35	93612	463361	3749433	40.1	0.002069	0.997931	462403	3659711	39.1	97.6
40	91733	452852	3286072	35.8	0.003097	0.996903	451449	3197308	34.9	97.3
45	89408	439627	2833220	31.7	0.004636	0.995364	437589	2745859	30.7	96.9
50	86443	423062	2393593	27.7	0.008000	0.992000	419678	2308270	26.7	96.4
55	82782	401527	1970531	23.8	0.010000	0.990000	397512	1888593	22.8	95.8
60	77829	372794	1569004	20.2	0.017000	0.983000	366457	1491081	19.2	95.0
65	71288	335432	1196210	16.8	0.020000	0.980000	328723	1124624	15.8	94.0
70	62884	288435	860778	13.7	0.031000	0.969000	279494	795901	12.7	92.5
75	52490	231572	572342	10.9	0.043000	0.957000	221615	516407	9.8	90.2
80	40139	167598	340770	8.5	0.088000	0.912000	152850	294792	7.3	86.5
85	26900	103794	173172	6.4	0.135000	0.865000	89782	141943	5.3	82.0
90	14618	50463	69377	4.7	0.261000	0.739000	37292	52160	3.6	75.2
95	5568	16497	18914	3.4	0.172000	0.828000	13659	14868	2.7	78.6
Females										
0	100000	99529	7812340	78.1	0.000028	0.999972	99526	7661004	76.6	98.1
1	99328	396837	7712811	77.7	0.000036	0.999964	396823	7561477	76.1	98.0
5	99091	494982	7315974	73.8	0.000056	0.999944	494954	7164654	72.3	97.9
10	98902	494021	6820992	69.0	0.000093	0.999907	493975	6669700	67.4	97.8
15	98707	492878	6326971	64.1	0.000153	0.999847	492803	6175725	62.6	97.6
20	98445	491441	5834092	59.3	0.000253	0.999747	491317	5682922	57.7	97.4
25	98132	489455	5342651	54.4	0.000416	0.999584	489251	5191605	52.9	97.2
30	97650	486592	4853196	49.7	0.000686	0.999314	486258	4702354	48.2	96.9
35	96987	482959	4366605	45.0	0.001132	0.998868	482412	4216096	43.5	96.6
40	96197	478422	3883646	40.4	0.001866	0.998134	477530	3733684	38.8	96.1
45	95172	472306	3405224	35.8	0.003076	0.996924	470853	3256155	34.2	95.6
50	93751	463579	2932917	31.3	0.006000	0.994000	460798	2785301	29.7	95.0
55	91681	450598	2469338	26.9	0.009000	0.991000	446543	2324504	25.4	94.1
60	88558	431204	2018740	22.8	0.014000	0.986000	425167	1877961	21.2	93.0
65	83923	403119	1587536	18.9	0.017000	0.983000	396266	1452794	17.3	91.5
70	77324	363805	1184417	15.3	0.034000	0.966000	351436	1056528	13.7	89.2
75	68198	309865	820612	12.0	0.052000	0.948000	293752	705092	10.3	85.9
80	55748	239204	510746	9.2	0.113000	0.887000	212174	411340	7.4	80.5
85	39933	157576	271543	6.8	0.205000	0.795000	125273	199166	5.0	73.3
90	23097	81107	113966	4.9	0.332000	0.668000	54179	73893	3.2	64.8
95	9345	28138	32859	3.5	0.387000	0.613000	17249	19713	2.1	60.0

Table A5: Mobility disability free life expectancy 2002, Thailand

Age	Number of surviving to age x	Person years lived in age interval between age x to x+n	Total numbers of years lived from age x	Total life expectancy	Proportion with mobility disability	Proportion with mobolity disability free	Person years lived free from mobility disability in age interval	Total years lived free from mobility disability from age x	Mobility disability free life expectancy	Percent of life spent free from mobility disability
x	**l_x**	**${}_nL_x$**	**T_x**	**e_x**	**${}_nMD_x$**	**${}_nMDF_x$**	**$({}_nMDF_x){}_nL_x$**	**$\Sigma({}_nMDF_x){}_nL_x$**	**$MDFLE_x$**	**$MDFLE_x/e_x$**
Males										
0	100000	99497	6940040	69.4	0.000567	0.999433	99441	6271940	62.7	90.4
1	99281	396162	6840543	68.9	0.000706	0.999294	395882	6172499	62.2	90.2
5	98799	493072	6444381	65.2	0.001046	0.998954	492556	5776617	58.5	89.6
10	98429	491371	5951309	60.5	0.001622	0.998378	490574	5284061	53.7	88.8
15	98119	488251	5459938	55.6	0.002513	0.997487	487024	4793487	48.9	87.8
20	97181	482720	4971687	51.2	0.003895	0.996105	480840	4306463	44.3	86.6
25	95907	474621	4488967	46.8	0.006036	0.993964	471756	3825623	39.9	85.2
30	93942	463257	4014345	42.7	0.009354	0.990646	458923	3353866	35.7	83.5
35	91361	450502	3551089	38.9	0.014497	0.985503	443971	2894943	31.7	81.5
40	88840	437684	3100587	34.9	0.022466	0.977534	427851	2450972	27.6	79.0
45	86234	423785	2662902	30.9	0.034817	0.965183	409030	2023121	23.5	76.0
50	83280	407059	2239117	26.9	0.044000	0.956000	389149	1614090	19.4	72.1
55	79543	385523	1832058	23.0	0.069000	0.931000	358921	1224942	15.4	66.9
60	74666	358433	1446535	19.4	0.146000	0.854000	306102	866020	11.6	59.9
65	68708	323969	1088102	15.8	0.239000	0.761000	246540	559918	8.1	51.5
70	60880	276550	764134	12.6	0.438000	0.562000	155421	313378	5.1	41.0
75	49740	215769	487584	9.8	0.564000	0.436000	94075	157957	3.2	32.4
80	36567	147634	271815	7.4	0.711000	0.289000	42666	63882	1.7	23.5
85	22486	82227	124181	5.5	0.820000	0.180000	14801	21216	0.9	17.1
90	10405	33389	41954	4.0	0.856000	0.144000	4808	6415	0.6	15.3
95	2951	8034	8565	2.9	0.800000	0.200000	1607	1607	0.5	18.8
Females										
0	100000	99569	7538572	75.4	0.007325	0.992675	98839	6106828	61.1	81.0
1	99384	396664	7439004	74.9	0.008484	0.991516	393299	6007989	60.5	80.8
5	98948	493973	7042339	71.2	0.011051	0.988949	488514	5614690	56.7	79.7
10	98641	492678	6548367	66.4	0.014824	0.985176	485374	5126176	52.0	78.3
15	98430	491416	6055689	61.5	0.019886	0.980114	481644	4640802	47.1	76.6
20	98136	489412	5564273	56.7	0.026676	0.973324	476356	4159158	42.4	74.7
25	97629	485526	5074861	52.0	0.035784	0.964216	468152	3682802	37.7	72.6
30	96582	480199	4589336	47.5	0.048001	0.951999	457148	3214650	33.3	70.0
35	95498	474940	4109137	43.0	0.064391	0.935609	444358	2757502	28.9	67.1
40	94478	469420	3634197	38.5	0.086376	0.913624	428873	2313143	24.5	63.6
45	93290	462440	3164777	33.9	0.115867	0.884133	408858	1884270	20.2	59.5
50	91686	452648	2702337	29.5	0.116000	0.884000	400141	1475412	16.1	54.6
55	89373	438526	2249689	25.2	0.181000	0.819000	359153	1075271	12.0	47.8
60	86038	419088	1811163	21.1	0.339000	0.661000	277017	716118	8.3	39.5
65	81598	392010	1392075	17.1	0.475000	0.525000	205805	439100	5.4	31.5
70	75206	347760	1000065	13.3	0.664000	0.336000	116847	233295	3.1	23.3
75	63897	281722	652305	10.2	0.769000	0.231000	65078	116448	1.8	17.9
80	48791	199328	370583	7.6	0.819000	0.181000	36078	51370	1.1	13.9
85	30940	113582	171256	5.5	0.899000	0.101000	11472	15292	0.5	8.9
90	14493	46264	57674	4.0	0.934000	0.066000	3053	3820	0.3	6.6
95	4012	10799	11410	2.8	0.929000	0.071000	767	767	0.2	6.7

Table A6: Mobility disability free life expectancy 2007, Thailand

Age	Number of surviving to age x	Person years lived in age interval between age x to x+n	Total numbers of years lived from age x	Total life expectancy	Proportion with mobility disability	Proportion with mobolity disability free	Person years lived free from mobility disability in age interval	Total years lived free from mobility disability from age x	Mobility disability free life expectancy	Percent of life spent free from mobility disability
x	l_x	${}_nL_x$	T_x	e_x	${}_nMD_x$	${}_nMDF_x$	$({}_nMDF_x){}_nL_x$	$\Sigma({}_nMDF_x){}_nL_x$	$MDFLE_x$	$MDFLE_x/e_x$
Males										
0	100000	99421	7155699	71.6	0.000309	0.999691	99390	6573045	65.7	91.9
1	99173	396082	7056279	71.2	0.000390	0.999610	395928	6473655	65.3	91.7
5	98869	493682	6660196	67.4	0.000591	0.999409	493391	6077727	61.5	91.3
10	98604	492292	6166514	62.5	0.000937	0.999063	491830	5584336	56.6	90.6
15	98312	489282	5674222	57.7	0.001488	0.998512	488554	5092506	51.8	89.7
20	97400	484506	5184941	53.2	0.002361	0.997639	483362	4603953	47.3	88.8
25	96402	478989	4700435	48.8	0.003748	0.996252	477194	4120591	42.7	87.7
30	95194	472013	4221446	44.3	0.005948	0.994052	469205	3643397	38.3	86.3
35	93612	463361	3749433	40.1	0.009439	0.990561	458988	3174192	33.9	84.7
40	91733	452852	3286072	35.8	0.014981	0.985019	446068	2715204	29.6	82.6
45	89408	439627	2833220	31.7	0.023776	0.976224	429174	2269136	25.4	80.1
50	86443	423062	2393593	27.7	0.033000	0.967000	409101	1839962	21.3	76.9
55	82782	401527	1970531	23.8	0.051000	0.949000	381049	1430861	17.3	72.6
60	77829	372794	1569004	20.2	0.107000	0.893000	332905	1049812	13.5	66.9
65	71288	335432	1196210	16.8	0.163000	0.837000	280757	716907	10.1	59.9
70	62884	288435	860778	13.7	0.306000	0.694000	200174	436150	6.9	50.7
75	52490	231572	572342	10.9	0.432000	0.568000	131533	235976	4.5	41.2
80	40139	167598	340770	8.5	0.607000	0.393000	65866	104443	2.6	30.6
85	26900	103794	173172	6.4	0.722000	0.278000	28855	38577	1.4	22.3
90	14618	50463	69377	4.7	0.874000	0.126000	6358	9722	0.7	14.0
95	5568	16497	18914	3.4	0.820000	0.180000	2969	3363	0.6	17.8
Females										
0	100000	99529	7812340	78.1	0.002011	0.997989	99329	6583129	65.8	84.3
1	99328	396837	7712811	77.7	0.002416	0.997584	395879	6483800	65.3	84.1
5	99091	494982	7315974	73.8	0.003361	0.996639	493319	6087922	61.4	83.2
10	98902	494021	6820992	69.0	0.004849	0.995151	491625	5594603	56.6	82.0
15	98707	492878	6326971	64.1	0.006998	0.993002	489429	5102978	51.7	80.7
20	98445	491441	5834092	59.3	0.010098	0.989902	486479	4613548	46.9	79.1
25	98132	489455	5342651	54.4	0.014571	0.985429	482323	4127069	42.1	77.2
30	97650	486592	4853196	49.7	0.021026	0.978974	476361	3644746	37.3	75.1
35	96987	482959	4366605	45.0	0.030340	0.969660	468306	3168386	32.7	72.6
40	96197	478422	3883646	40.4	0.043781	0.956219	457477	2700080	28.1	69.5
45	95172	472306	3405224	35.8	0.063176	0.936824	442468	2242603	23.6	65.9
50	93751	463579	2932917	31.3	0.069000	0.931000	431592	1800135	19.2	61.4
55	91681	450598	2469338	26.9	0.121000	0.879000	396076	1368543	14.9	55.4
60	88558	431204	2018740	22.8	0.222000	0.778000	335476	972467	11.0	48.2
65	83923	403119	1587536	18.9	0.322000	0.678000	273315	636991	7.6	40.1
70	77324	363805	1184417	15.3	0.529000	0.471000	171352	363676	4.7	30.7
75	68198	309865	820612	12.0	0.625000	0.375000	116199	192323	2.8	23.4
80	55748	239204	510746	9.2	0.794000	0.206000	49276	76124	1.4	14.9
85	39933	157576	271543	6.8	0.877000	0.123000	19382	26848	0.7	9.9
90	23097	81107	113966	4.9	0.933000	0.067000	5434	7466	0.3	6.6
95	9345	28138	32859	3.5	0.935000	0.065000	1829	2032	0.2	6.2

Appendix B

Population Projection for Thailand 2000-2050

Table B.1: Population projection for Thailand 2000-2050 (Author's assumption)

Age	P_x										
Males	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
0-4	2,484,049	2,449,413	2,312,882	2,224,708	2,015,966	1,793,882	1,588,521	1,388,418	1,191,568	1,116,793	1,027,386
5-9	2,689,780	2,459,553	2,437,670	2,304,430	2,218,789	2,011,830	1,791,087	1,586,845	1,387,728	1,191,700	1,117,342
10-14	2,691,905	2,684,024	2,458,224	2,437,155	2,304,768	2,219,537	2,012,981	1,792,603	1,588,675	1,389,817	1,194,012
15-19	2,724,091	2,685,175	2,681,394	2,456,891	2,436,600	2,304,765	2,219,875	2,013,756	1,793,786	1,590,186	1,391,609
20-24	2,724,893	2,712,482	2,679,770	2,677,337	2,454,547	2,434,879	2,303,676	2,219,266	2,013,782	1,794,367	1,591,226
25-29	2,725,315	2,709,113	2,704,457	2,673,578	2,672,692	2,451,297	2,432,190	2,301,741	2,217,934	2,013,179	1,794,424
30-34	2,727,196	2,705,676	2,698,591	2,695,971	2,667,042	2,667,128	2,447,032	2,428,535	2,298,944	2,215,754	2,011,792
35-39	2,591,880	2,700,403	2,690,297	2,685,802	2,685,540	2,658,014	2,658,991	2,440,480	2,422,775	2,294,176	2,211,731
40-44	2,306,913	2,554,683	2,676,307	2,669,757	2,668,509	2,670,126	2,644,136	2,646,352	2,430,136	2,413,451	2,286,226
45-49	1,826,991	2,256,423	2,517,492	2,642,123	2,640,222	2,641,895	2,645,738	2,622,026	2,626,215	2,413,277	2,398,082
50-54	1,399,877	1,764,187	2,201,374	2,462,458	2,590,871	2,593,661	2,599,118	2,606,389	2,586,431	2,593,415	2,385,543
55-59	1,116,282	1,324,048	1,692,367	2,119,595	2,379,633	2,511,133	2,520,294	2,531,508	2,544,407	2,529,770	2,540,952
60-64	941,852	1,021,658	1,235,617	1,587,760	1,999,106	2,255,328	2,390,528	2,408,930	2,429,193	2,449,617	2,442,698
65-69	713,130	819,691	913,641	1,113,470	1,441,858	1,829,885	2,079,824	2,219,383	2,251,161	2,282,525	2,312,969
70-74	493,667	576,083	687,701	774,863	954,817	1,252,259	1,608,787	1,848,668	1,993,752	2,040,159	2,084,877
75-79	277,122	358,514	439,885	532,883	609,459	766,203	1,024,940	1,340,193	1,566,372	1,713,092	1,774,914
80-84	167,110	172,710	237,598	296,919	366,554	432,867	562,123	773,795	1,039,814	1,242,697	1,386,272
85-89	52,609	84,125	93,397	131,399	167,969	218,404	272,011	369,886	531,679	739,781	911,787
90-94	9,284	20,224	35,186	40,102	57,922	80,457	113,778	152,031	220,538	333,608	485,597
95-99	1,547	2,590	6,196	11,106	13,011	21,500	33,930	53,157	77,827	121,137	195,035
100+	-	278	536	1,320	2,469	3,865	7,854	14,945	27,560	46,486	80,350
All ages	30,665,493	32,061,054	33,400,585	34,539,629	35,348,345	35,818,914	35,957,413	35,758,906	35,240,275	34,524,987	33,624,822
Females											
0-4	2,348,707	2,346,192	2,195,900	2,105,586	1,902,528	1,690,434	1,495,510	1,306,074	1,119,996	1,049,057	964,592
5-9	2,562,555	2,335,476	2,336,935	2,187,750	2,098,186	1,896,388	1,685,546	1,491,740	1,303,336	1,118,226	1,047,720
10-14	2,566,164	2,561,595	2,335,817	2,337,352	2,188,417	2,099,020	1,897,511	1,686,954	1,493,400	1,305,230	1,120,340
15-19	2,631,705	2,565,583	2,561,962	2,336,515	2,338,116	2,189,403	2,100,158	1,898,908	1,688,605	1,495,276	1,307,317
20-24	2,687,731	2,629,506	2,564,816	2,561,309	2,336,298	2,337,986	2,189,570	2,100,530	1,899,622	1,689,658	1,496,631
25-29	2,848,995	2,683,161	2,626,870	2,562,460	2,559,098	2,334,653	2,336,455	2,188,429	2,099,652	1,899,190	1,689,667
30-34	2,906,219	2,840,845	2,678,017	2,622,081	2,558,028	2,554,847	2,331,137	2,333,091	2,185,564	2,097,124	1,897,241
35-39	2,735,308	2,893,055	2,831,527	2,669,612	2,614,147	2,550,570	2,547,639	2,324,929	2,327,079	2,180,225	2,092,246
40-44	2,438,564	2,715,969	2,877,784	2,817,050	2,656,437	2,601,640	2,538,756	2,536,193	2,314,909	2,317,339	2,171,459
45-49	1,940,797	2,411,203	2,692,910	2,853,977	2,794,403	2,635,706	2,581,911	2,520,068	2,518,029	2,298,858	2,301,712
50-54	1,485,000	1,906,204	2,378,455	2,657,269	2,817,176	2,759,314	2,603,518	2,551,248	2,490,934	2,489,669	2,273,700
55-59	1,208,076	1,442,769	1,864,824	2,328,148	2,602,513	2,760,595	2,705,353	2,553,984	2,503,966	2,445,951	2,445,882
60-64	1,054,183	1,152,544	1,392,093	1,801,078	2,250,650	2,518,091	2,673,379	2,622,159	2,477,458	2,430,839	2,376,369
65-69	836,516	974,550	1,085,933	1,313,815	1,702,492	2,130,633	2,387,324	2,538,243	2,493,005	2,358,516	2,317,150
70-74	600,265	734,110	883,204	986,885	1,197,170	1,555,284	1,951,265	2,191,699	2,335,600	2,299,021	2,179,723
75-79	357,437	486,879	627,910	758,871	851,614	1,037,343	1,353,122	1,704,376	1,921,540	2,055,055	2,029,997
80-84	253,870	254,267	379,204	492,753	599,826	677,777	831,142	1,091,235	1,383,048	1,568,580	1,687,321
85-89	87,817	146,289	171,622	259,208	340,922	419,876	479,742	594,582	788,716	1,009,579	1,155,928
90-94	19,160	38,444	83,253	99,556	153,220	205,270	257,155	298,508	375,830	506,174	657,199
95-99	1,597	6,093	18,380	40,885	50,209	79,376	108,900	139,356	165,376	212,708	292,068
100+	-	326	2,489	8,226	19,836	28,489	45,608	66,571	90,883	115,611	152,099
All ages	31,570,666	33,125,057	34,589,908	35,800,387	36,631,288	37,062,696	37,100,700	36,738,876	35,976,547	34,941,886	33,656,361

Appendix C

The Number of Disabled People in Thailand 2000-2050

Table C.1: Number of projected population with limiting in self-care activities for Thailand, 2000-2050 (Disability prevalence constant assumption)

Constant	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
Males											
60-64	13,186	14,303	17,299	22,229	27,987	31,575	33,467	33,725	34,009	34,295	34,198
65-69	13,549	15,574	17,359	21,156	27,395	34,768	39,517	42,168	42,772	43,368	43,946
70-74	14,563	16,994	20,287	22,858	28,167	36,942	47,459	54,536	58,816	60,185	61,504
75-79	11,916	15,416	18,915	22,914	26,207	32,947	44,072	57,628	67,354	73,663	76,321
80-84	13,452	13,903	19,127	23,902	29,508	34,846	45,251	62,290	83,705	100,037	111,595
85-89	5,603	8,959	9,947	13,994	17,889	23,260	28,969	39,393	56,624	78,787	97,105
90-94	1,861	4,055	7,055	8,040	11,613	16,132	22,812	30,482	44,218	66,888	97,362
95+	271	453	1,084	1,944	2,277	3,763	5,938	9,303	13,620	21,199	34,131
Females											
60-64	13,177	14,407	17,401	22,513	28,133	31,476	33,417	32,777	30,968	30,385	29,705
65-69	13,384	15,593	17,375	21,021	27,240	34,090	38,197	40,612	39,888	37,736	37,074
70-74	19,208	23,492	28,263	31,580	38,309	49,769	62,440	70,134	74,739	73,569	69,751
75-79	17,693	24,100	31,082	37,564	42,155	51,348	66,980	84,367	95,116	101,725	100,485
80-84	24,625	24,664	36,783	47,797	58,183	65,744	80,621	105,850	134,156	152,152	163,670
85-89	15,017	25,015	29,347	44,325	58,298	71,799	82,036	101,673	134,870	172,638	197,664
90-94	5,853	11,745	25,434	30,414	46,809	62,710	78,561	91,194	114,816	154,636	200,774
95+	497	1,898	5,725	12,736	15,640	24,726	33,922	43,409	51,515	66,259	90,979

Table C.2: Number of projected population with limiting in self-care activities for Thailand, 2000-2050 (Disability prevalence rate decrease 2% per 5 years assumption)

2% Decrease	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
Males											
60-64	13,186	14,017	16,614	20,921	25,815	28,541	29,647	29,278	28,933	28,593	27,942
65-69	13,549	15,263	16,672	19,912	25,269	31,427	35,006	36,607	36,389	36,158	35,907
70-74	14,563	16,655	19,484	21,514	25,980	33,392	42,041	47,344	50,038	50,179	50,253
75-79	11,916	15,108	18,166	21,566	24,172	29,781	39,041	50,029	57,302	61,416	62,360
80-84	13,452	13,625	18,369	22,496	27,217	31,498	40,085	54,076	71,213	83,406	91,181
85-89	5,603	8,780	9,553	13,171	16,500	21,025	25,662	34,198	48,173	65,688	79,342
90-94	1,861	3,974	6,775	7,568	10,712	14,582	20,208	26,462	37,619	55,768	79,552
95+	271	444	1,041	1,829	2,100	3,401	5,260	8,076	11,587	17,675	27,888
Females											
60-64	13,177	14,119	16,712	21,190	25,949	28,452	29,602	28,455	26,347	25,334	24,271
65-69	13,384	15,281	16,687	19,785	25,125	30,815	33,837	35,256	33,935	31,463	30,292
70-74	19,208	23,022	27,143	29,723	35,335	44,987	55,312	60,885	63,585	61,338	56,992
75-79	17,693	23,618	29,851	35,355	38,882	46,415	59,333	73,241	80,921	84,813	82,103
80-84	24,625	24,171	35,326	44,986	53,666	59,428	71,417	91,891	114,135	126,857	133,730
85-89	15,017	24,515	28,185	41,718	53,772	64,900	72,671	88,265	114,743	143,937	161,506
90-94	5,853	11,510	24,427	28,626	43,175	56,685	69,593	79,168	97,681	128,927	164,047
95+	497	1,860	5,499	11,987	14,426	22,350	30,050	37,685	43,827	55,243	74,337

Table C.3: Number of projected population with limiting in self-care activities for Thailand, 2000-2050 (Disability prevalence rate increase 2% per 5 years assumption)

2% Increase	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Males											
60-64	13,186	14,589	17,998	23,589	30,295	34,861	37,690	38,739	39,847	40,985	41,687
65-69	13,549	15,886	18,060	22,451	29,654	38,386	44,502	48,438	50,114	51,829	53,570
70-74	14,563	17,334	21,107	24,258	30,489	40,787	53,447	62,644	68,912	71,926	74,973
75-79	11,916	15,724	19,679	24,317	28,367	36,376	49,633	66,197	78,916	88,034	93,035
80-84	13,452	14,181	19,899	25,365	31,940	38,473	50,960	71,552	98,074	119,554	136,034
85-89	5,603	9,138	10,349	14,851	19,363	25,681	32,624	45,250	66,344	94,157	118,371
90-94	1,861	4,136	7,340	8,533	12,571	17,811	25,690	35,014	51,808	79,938	118,684
95+	271	462	1,128	2,063	2,465	4,154	6,687	10,686	15,958	25,335	41,606
Females											
60-64	13,177	14,695	18,104	23,891	30,452	34,752	37,633	37,650	36,284	36,313	36,210
65-69	13,384	15,905	18,077	22,308	29,485	37,638	43,016	46,650	46,735	45,098	45,193
70-74	19,208	23,961	29,404	33,513	41,467	54,949	70,318	80,562	87,569	87,921	85,026
75-79	17,693	24,582	32,337	39,863	45,630	56,693	75,430	96,911	111,444	121,571	122,490
80-84	24,625	25,157	38,269	50,723	62,979	72,587	90,792	121,588	157,185	181,836	199,513
85-89	15,017	25,516	30,533	47,038	63,103	79,272	92,386	116,791	158,022	206,318	240,951
90-94	5,853	11,980	26,461	32,276	50,667	69,237	88,472	104,753	134,525	184,804	244,743
95+	497	1,936	5,957	13,515	16,929	27,299	38,202	49,864	60,357	79,185	110,903

Table C.4: Number of projected population with limiting in mobility activities for Thailand, 2000-2050 (Disability prevalence constant assumption)

Constant	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Males											
60-64	119,144	129,240	156,306	200,852	252,887	285,299	302,402	304,730	307,293	309,877	309,001
65-69	143,339	164,758	183,642	223,807	289,814	367,807	418,045	446,096	452,483	458,787	464,907
70-74	183,644	214,303	255,825	288,249	355,192	465,841	598,469	687,704	741,676	758,939	775,574
75-79	138,007	178,540	219,063	265,376	303,510	381,569	510,420	667,416	780,053	853,120	883,907
80-84	110,125	113,816	156,577	195,669	241,559	285,259	370,439	509,931	685,237	818,937	913,553
85-89	40,562	64,860	72,009	101,309	129,504	168,389	209,720	285,182	409,924	570,371	702,987
90-94	8,031	17,493	30,436	34,688	50,102	69,595	98,418	131,507	190,766	288,571	420,042
95+	1,254	2,099	5,022	9,002	10,545	17,426	27,500	43,084	63,079	98,182	158,076
Females											
60-64	295,698	323,288	390,482	505,202	631,307	706,325	749,883	735,515	694,927	681,850	666,571
65-69	333,352	388,358	432,744	523,555	678,443	849,057	951,349	1,011,490	993,463	939,869	923,384
70-74	358,058	437,896	526,831	588,677	714,112	927,727	1,163,930	1,307,349	1,393,186	1,371,366	1,300,205
75-79	249,134	339,354	437,653	528,933	593,575	723,028	943,126	1,187,950	1,339,313	1,432,373	1,414,908
80-84	204,746	205,066	305,828	397,405	483,760	546,627	670,316	880,081	1,115,429	1,265,059	1,360,824
85-89	77,981	129,905	152,400	230,177	302,739	372,850	426,011	527,988	700,379	896,506	1,026,464
90-94	17,886	35,887	77,717	92,935	143,031	191,620	240,055	278,657	350,837	472,513	613,495
95+	1,488	5,678	17,130	38,105	46,794	73,978	101,495	129,880	154,130	198,244	272,207

Table C.5: Number of projected population with limiting in mobility activities for Thailand, 2000-2050 (Disability prevalence rate decrease 2% per 5 years assumption)

2% Decrease	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Males											
60-64	119,144	126,655	150,116	189,040	233,255	257,888	267,880	264,544	261,433	258,359	252,477
65-69	143,339	161,463	176,370	210,646	267,315	332,468	370,322	387,267	384,956	382,513	379,863
70-74	183,644	210,017	245,694	271,298	327,618	421,083	530,149	597,014	630,990	632,764	633,701
75-79	138,007	174,969	210,388	249,770	279,948	344,908	452,152	579,401	663,640	711,287	722,216
80-84	110,125	111,540	150,377	184,162	222,807	257,852	328,150	442,684	582,974	682,787	746,439
85-89	40,562	63,563	69,157	95,351	119,450	152,210	185,779	247,574	348,749	475,546	574,392
90-94	8,031	17,144	29,230	32,648	46,213	62,908	87,182	114,164	162,296	240,595	343,205
95+	1,254	2,057	4,823	8,472	9,727	15,752	24,361	37,402	53,665	81,859	129,160
Females											
60-64	295,698	316,823	375,019	475,493	582,298	638,462	664,278	638,520	591,218	568,491	544,637
65-69	333,352	380,591	415,608	492,766	625,774	767,480	842,745	878,100	845,201	783,613	754,472
70-74	358,058	429,138	505,968	554,058	658,674	838,592	1,031,058	1,134,943	1,185,271	1,143,373	1,062,362
75-79	249,134	332,567	420,322	497,828	547,495	653,560	835,461	1,031,290	1,139,438	1,194,238	1,156,083
80-84	204,746	200,965	293,718	374,035	446,204	494,108	593,794	764,021	948,965	1,054,741	1,111,893
85-89	77,981	127,306	146,365	216,641	279,237	337,027	377,379	458,360	595,857	747,460	838,696
90-94	17,886	35,170	74,639	87,470	131,928	173,209	212,651	241,909	298,479	393,957	501,270
95+	1,488	5,565	16,452	35,864	43,162	66,871	89,908	112,752	131,128	165,285	222,413

Table C.6: Number of projected population with limiting in mobility activities for Thailand, 2000-2050 (Disability prevalence rate increase 2% per 5 years assumption)

2% Increase	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Males											
60-64	119,144	131,825	162,620	213,145	273,733	314,993	340,553	350,039	360,043	370,331	376,671
65-69	143,339	168,053	191,061	237,506	313,703	406,089	470,786	512,424	530,156	548,293	566,719
70-74	183,644	218,589	266,160	305,892	384,471	514,326	673,973	789,956	868,991	907,002	945,421
75-79	138,007	182,111	227,913	281,619	328,530	421,283	574,816	766,651	913,957	1,019,557	1,077,478
80-84	110,125	116,092	162,903	207,646	261,472	314,949	417,174	585,750	802,864	978,706	1,113,616
85-89	40,562	66,158	74,918	107,509	140,179	185,915	236,179	327,585	480,292	681,647	856,938
90-94	8,031	17,843	31,665	36,811	54,232	76,839	110,834	151,060	223,512	344,868	512,028
95+	1,254	2,141	5,225	9,553	11,415	19,240	30,970	49,490	73,907	117,336	192,694
Females											
60-64	295,698	329,754	406,258	536,125	683,347	779,840	844,490	844,876	814,218	814,874	812,547
65-69	333,352	396,125	450,227	555,601	734,369	937,428	1,071,373	1,161,884	1,164,000	1,123,230	1,125,600
70-74	358,058	446,654	548,115	624,709	772,978	1,024,285	1,310,774	1,501,733	1,632,339	1,638,909	1,584,942
75-79	249,134	346,141	455,335	561,308	642,505	798,282	1,062,113	1,364,581	1,569,219	1,711,819	1,724,765
80-84	204,746	209,167	318,184	421,730	523,637	603,521	754,885	1,010,937	1,306,902	1,511,863	1,658,837
85-89	77,981	132,503	158,557	244,265	327,695	411,656	479,758	606,493	820,606	1,071,408	1,251,254
90-94	17,886	36,605	80,856	98,624	154,822	211,564	270,340	320,089	411,062	564,697	747,847
95+	1,488	5,792	17,823	40,437	50,652	81,678	114,300	149,191	180,588	236,920	331,819