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The Trajectories and Risk Factors of Health Status in the Elderly

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Abstract

The Trajectories and Risk Factors of Health Status in the Elderly

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Introduction: Population aging has become a global problem, especially, the rapid aging of South Korea is unrivaled, resulting in a dim forecast of becoming the second oldest country in the world in 2050. Therefore, identifying the health status and the associated risk factors of the elderly is very important in order to reduce the national burden. The objectives of the present study were to investigate the association between self-rated health and socioeconomic positions in life course, examine the changes in the trajectories of depressive symptoms and identify the risk factors that influence these aforementioned changes according to gender, determine changing patterns in the pain trajectories and demonstrate the causes of these changes according to gender, and finally, determine the long-term effect of depressive symptoms on all-cause mortality in the Korean elderly.

Methods: First, 1,000 older adults were randomly allocated, and they conducted a face-to-face interview using a self-developed questionnaire. Self-rated health status, socioeconomic variables throughout life course, and demographic variables were included in the analysis. Secondly, 3,667 individuals (1,566 men and 2,101 women) aged 60 years and above were selected from a subsample of subjects who participated in the Korean Longitudinal Study of Ageing between 2006 and 2012. Thirdly, 2,820 individuals (1,171 men and 1,649 women) aged 60 years and above were included from a subsample of subjects who participated in the Korean Longitudinal Study of Ageing between 2006 and 2014. Lastly, 5,501 individuals (2,359 men and 3,142 women) aged 60 years and above were included from a subsample of subjects who participated in the Korean Longitudinal Study of Ageing between 2006 and 2014. A group-based trajectory model was utilized to determine the appropriate number of groups and also to observe changes in health outcomes for chapter II to IV. Following the trajectory analysis, a multinomial regression analysis was performed to examine health outcomes and related risk factors that influenced the membership of the different trajectory groups. Kaplan-Meier analysis and Cox Proportional Hazard regression analysis with and without time-varying covariates were conducted to determine the association between depressive symptoms and all-cause mortality.

Results: First of all, the elderly men who experienced skipping meals during their childhood and those with chronic disease conditions were more likely to be in the lower health trajectory, and the likelihood of being in the lower health trajectory among elderly women were increased by experiences of skipping meals, lower house income, housekeeping labor, and chronic disease conditions. Secondly,

chronic diseases, self-rated health, and somatic pain were associated with depressive symptoms in both genders and statistically significant differences were found in terms of employment in older men and social participation in older women. Thirdly, lack of physical activity, chronic disease, and depressive symptoms were risk factors for having more pain sites in both genders. The longest job demanding manual work, experience of injuries, and married status were associated with pain in men but not in women; household income, in contrast, was a risk factor of pain only in women. Finally, depressive symptoms had a negative effect on all-cause mortality, and men had a higher risk of mortality than women. The protective effect of social participation has been confirmed in both genders.

Conclusions: The health status in later life is the cumulative result of the various experiences undergone during the life course, and initial values of health status should be measured and monitored. In addition, maintenance of physical health is also beneficial in maintaining mental health. Also, employment policies that reflect the physical and mental conditions of the elderly and social welfare policies that allow the formation of social network among the elderly are crucial in improving the elderly's mental health status. Moreover, most of elderly men and women suffered from persistent pain suggesting the need for improved intervention before pain becomes chronic. Modifying the risk factors, as well as early treatment of pain among those with risk factors should be considered. Greater efforts are necessary for monitoring and investigation of pain among the older population in order to reduce the socioeconomic burden associated with pain. Lastly, spatial and policy environment should be created for the elderly to participate in society to reduce the risk of mortality associate with depressive symptoms.

Keywords: Health trajectories, Risk factors, Life course approach, Group-based trajectory model, Self-rated health, Depressive symptoms, Pain, All-cause mortality, Trajectory analysis, Survival analysis

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CHAPTER I.

Introduction

Population aging

Population aging has become a global problem, and two-thirds of the Organisation for Economic Co-operation and Development (OECD) member countries have been predicted that the elderly, aged over 65, will account for 25 percent of the overall population by 2050 (OECD, 2015). Especially, the rapid aging of South Korea is unrivaled as shown in Figure 1.1; the proportion of the elderly population in 2010 is relatively low, but the proportion increased at an alarming rate, resulting in the second oldest country in the world. Change in population structure due to rapid aging will require a change in almost all the environment that surrounds the country; the country will fall into great confusion if the pace of environmental change cannot keep up with that of population aging.

Aging causes a variety of problems at the national level such as heavy burden of social welfare services or costs of public pension, and also induces a variety of negative symptoms at the individual level in terms of health, such as lower body function, frailty, or cognitive dysfunction. In particular, the elderly who evaluated their subjective health as poor was 43.7%, and almost every older population (almost 90%) had chronic disease; 70% suffer from co-morbidity (Ministry of Health & Welfare, 2014b). In addition, rapid increase in the older population due to entering of a super-aged society will cause more health problems, and these phenomena will lead to an increase in national expenditures for providing health care services. Therefore, identifying the health status and the associated risk factors of the elderly is very important in order to reduce national burden.

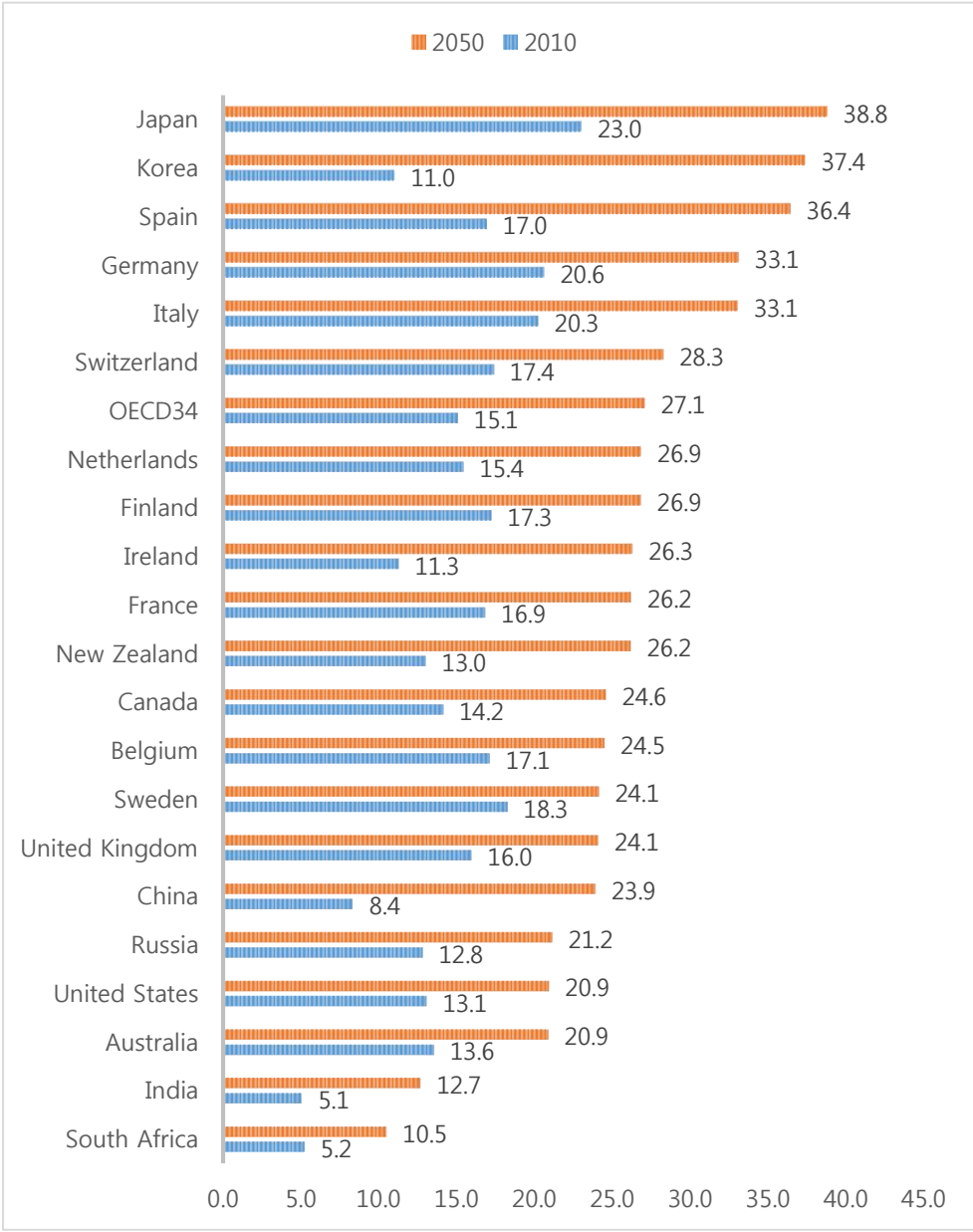

Figure 1.1. Share of the population aged over 65 and 80 years, 2010 and 2050 (*Source*: OECD Historical Population Data and Projections Database, 2015)

Ecological model of aging and health status of the elderly

The ecological model of aging introduced by Satariano (Satariano, 2006), was quoted and modified in the present study according to the study objectives. The top circle presents various factors surrounding the elderly; each variable has an effect on each other except for age and gender which are unchangeable, and these factors affect the under circle. The second circle consisted of health outcomes like disease, injury, depression, cognitive functioning and physical functioning; it also has a mutual influence among health variables. Finally, these pathways lead to the third circle as the final stage which is divided into either alive or dead.

As shown in Figure 1.2, there are a wide variety of factors affecting the aging process and these are closely connected to each other. As such, the health status of the elderly can be evaluated using various indices influenced by various factors. Thus, comprehensive understanding of risk factors and health outcomes are essential in order to determine the health status of the elderly. For these reasons, the present study conducted to demonstrate the health status and related risk factors among the elderly comprehensively; self-rated health is used as a parameter representing the overall health status, and depressive symptoms have been studied as a variable that represent the mental health status, and pain is used as a variable that can estimate the physical health status among the elderly. In addition, the effect of depressive symptoms on total mortality was studied as the final stage of aging.

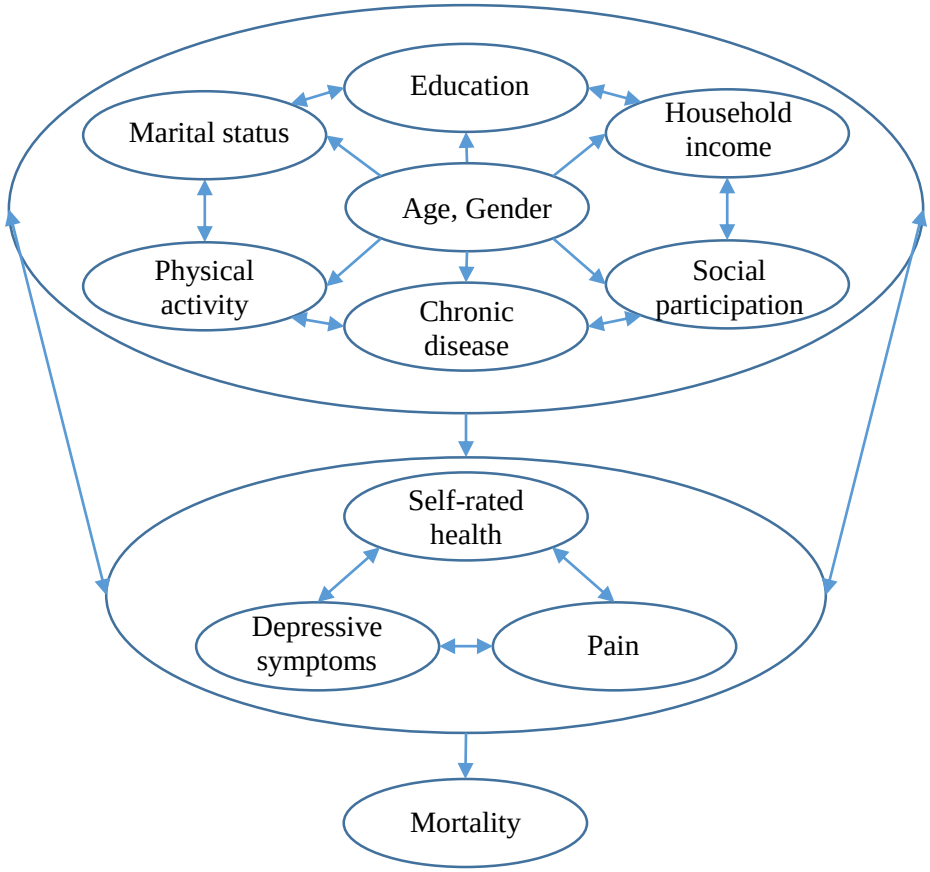

Figure 1.2. Modified ecological model of aging (*Source*: Quoted and modified from Satariano, 2006)

Life course approach

It is generally accepted that health status of later life is affected by not only risk factors of later life but also those of life courses (fetal life, early childhood, childhood, adolescence and adulthood) (Ben-Shlomo & Kuh, 2002; Chittleborough, Baum, Taylor, & Hiller, 2006; D. Kuh, Ben-Shlomo, Lunch, Hallqvist, & Power, 2003). The theoretical framework of the present study is based on life course approach (Ben-Shlomo & Kuh, 2002). Life course approach (LCA) was defined as the study which investigates long-standing effects of various exposures during life course on health (D. Kuh & Ben-Shlomo, 1997), and the purpose of this approach is to find the cause of differences in health status that occur in later life as shown in Figure 1.3 (Kalache & Kickbusch, 1997). 'The Notion of Time' is the fundamental feature of the LCA, which is the most suitable method to investigate personal responses and changes (D. Kuh et al., 2003; Lynch & Smith, 2005). LCA demonstrates how health status at any certain age reflects not only conditions at the same age but also previous living environments (Chittleborough et al., 2006), and also provides important information for understanding elderly's present health status, quality of life and SES, since the gap among elderly has maximized at a later life.

In the perspective of LCA, two major conceptual models are suggested to explain the association between previous circumstances and health status in later life: the critical period model and the accumulation of risk model (Ben-Shlomo & Kuh, 2002). The critical period model focuses on the significance of timing of exposure, and includes two sub-models: the model with or without later life risk factors, and with later life effect modifiers. The accumulation of risk model emphasizes the

significance of exposure during life course and the sequence of exposure, and the model is separated into ‘the model with independent and uncorrelated insults’ and ‘the model with correlated insults’. Despite this classification, it is hard to separate the effect of these conceptual models because the effect is closely interrelated in actual life (Rosvall, Chaix, Lynch, Lindström, & Merlo, 2006). In particular, the Korean elderly is a generation that has gone through a period of turbulence such as the Japanese colonial era and the Korean War, and their life history is included of those historic backgrounds. Therefore, life course study on the Korean elderly is required and an in-depth understanding of senescence formation process with consideration in temporal and spatial factors of Korea.

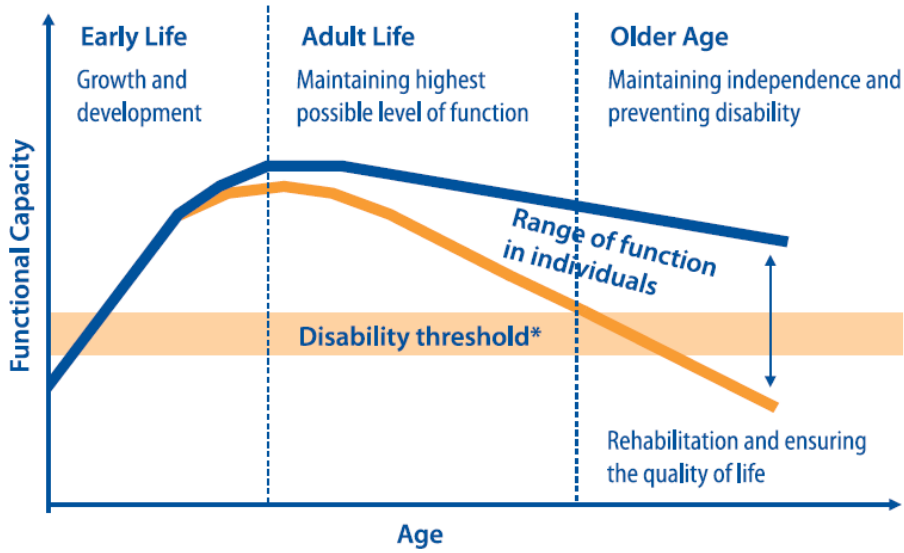

Figure 1.3. A life-course perspective to maintain the highest possible level of functional capacity (*Source*: Kalache and Kickbusch, 1997**;** Quoted and modified in WHO (2002), Active aging: a policy framework)

Group-based trajectory model (GBTM)

The data collected through a longitudinal study are indispensable in order to demonstrate the changes in the health status during life course. Longitudinal studies are conducted to determine changes in phenomena over time, therefore, this type of study design can be used to empirically demonstrate a causal association. In the perspective of analyzing developmental trajectories, most statistical approaches have been devised to explain individual changes about population trend represented by the mean value; however, most longitudinal analysis have qualitative challenging problems for instance, how to divide the meaningful sub-groups that show the distinctive trajectories which reflect the individual characteristics (D. S. Nagin, 2005).

In order to solve these problems, researchers often use a mixture of analyses to create the meaningful groups which are inevitably subjective because conventional statistical approaches to analyze longitudinal data are not suitable for identification of distinctive trajectories. However, researchers should pay more attention to the use of these methods because the methods involve some statistical risk such as producing the sub-groups which reflect only the random variation, and failing to establish significant but uncommon trajectories (D. S. Nagin, 2005). Besides blending of analysis methods, two major analytical methods are used to analyze developmental trajectories at an individual level: multilevel model and latent curve model (MacCallum, Kim, Malarkey, & Kiecolt-Glaser, 1997). Although multilevel model and latent curve model are very different in statistical assumptions, both models have some common points (MacCallum et al., 1997; Muthén & Curran,

1997). One important point between both models is that two methodologies make developmental trajectories based on continuous distribution functions (D. S. Nagin, 2005); the mean and covariance matrix are used for population distribution of dependent variable in unconditional models, and this fluctuation is related to the dependent variable for one or more independent variables. However, covariance cannot show the strength of the association even though it is used as an information showing the relationship between the two variables. Also, it has the biggest weakness that covariance is dependent on the unit of measure.

In addition, health trajectories cannot be identified by a simple comparison of the mean value used in traditional statistical methodologies because those are formed variously through individuals' life course. In these cases, group-based trajectory modeling (GBTM) is a very useful alternative that addresses some of these issues (D. S. Nagin, 2005). GBTM is designed to determine similar patterns of change in developmental trajectories with multinomial modeling strategy (Daniel S Nagin, 1999). For group-based trajectory analysis, PROC TRAJ as add-in module of SAS is used, and it can be said that this analysis has received a relatively less influence on the form of the dependent variable than traditional analyses.

Objectives of the present study

There is no doubt that health status and functional abilities are declined depending on the biological aging process as shown in Figure 1.4; group one refers to the most ideal aging process, while groups two and three mean that the initial status of health is low. Assuming that there is an aging process for each initial value of health status, groups that exhibit a lower health status than expected to each group will be generated inevitably. Comprehensively, Topics to be confirmed in the present study are among those who did start with lower health status like groups two or three and had sharply reduced health status in later life like groups four or five, and what affects these differences.

Therefore, the objectives of the present study were to 1) investigate the association between self-rated health and socioeconomic positions in life course, 2) examine the changes in the trajectories of depressive symptoms and identify the risk factors that influence these changes according to gender, 3) determine changing pattern in the pain trajectories and demonstrate causes of these changes according to gender, and finally, 4) determine the long-term effect of depressive symptoms on all-cause mortality in Korean elderly.

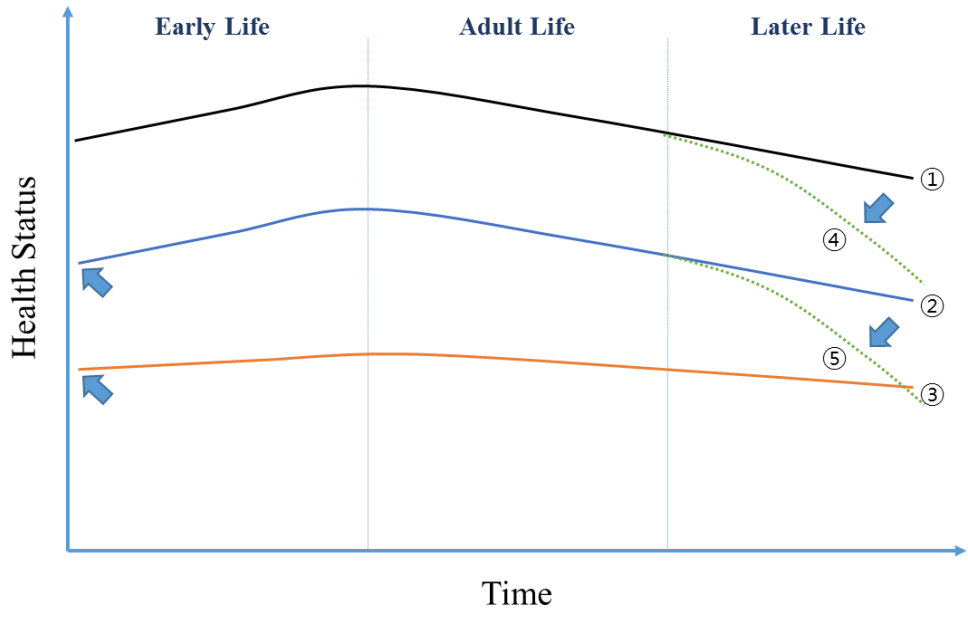

Figure 1.4. Analysis framework of life course as determinants of health

CHAPTER II.

Life Course Indices for Social Determinants of Self-rated Health Trajectory

Introduction

Self-rated health (SRH) is the indicator that measures perceived health status of individuals with a single question, and it used in various fields of epidemiologic research. SRH enables determination of integrated health status that encompasses biological, psychological, and social perspectives, and cannot be identified by external observers (Miilunpalo, Vuori, Oja, Pasanen, & Urponen, 1997). Identifying changing patterns of SRH and related risk factors during the life course is crucial for assessing the overall health status of the elderly. Health status in older adults is affected by the risk factors of later life, but also those present throughout the life course; from this point of view, an individual's health status can be affected by various experiences at different life-course stages (Ben-Shlomo & Kuh, 2002; Chittleborough, Baum, Taylor, & Hiller, 2006; D. Kuh, Ben-Shlomo, Lunch, Hallqvist, & Power, 2003; Lynch & Smith, 2005). In general, studies on the health status of the elderly tend to stratify the subjects by age or gender and focus on the trends of health risk factors; it allows to identify changes in health risks in the target population for intervention of the risks. However, in-depth investigation of the characteristics of the elderly is needed for more effective interventions since older individuals have various trajectories according to life-course.

SEP is an important health-related resource for the older population (Grundy & Holt, 2001). However, measuring SEP at only one point in time cannot provide adequate information to explain the overall contribution of SEP to health status because the health status of the elderly population is also strongly associated with lifelong SEP; thus, the cumulative and dynamic nature of SEP is taken into

consideration by the life-course approach (Duncan, Daly, McDonough, & Williams, 2002; Guralnik, Butterworth, Wadsworth, & Kuh, 2006; Smith, Hart, Blane, Gillis, & Hawthorne, 1997). In particular, poor socioeconomic conditions in early life exert a long-lasting effect (Diana Kuh & Smith, 1993; Wen & Gu, 2011); indeed, recent studies have reported a significant relationship between low early-life SEP and SRH (Haas, 2007; Wen & Gu, 2011). Although there is consensus on the importance of SEP as one of the risk factors that affect health status and quality of life amongst the elderly, accurate and measurable indicators of SEP in older adults are not yet available.

The theoretical framework of the present study is based on the life-course approach (LCA) (Ben-Shlomo & Kuh, 2002). The LCA is defined as the study of the long-lasting effects on health risks of different types of exposure during the life course (from gestation to later life) (D. Kuh & Ben-Shlomo, 1997), and scholars in various disciplines have used the LCA to address these specific problems (D. Kuh et al., 2003). The LCA involves biological, behavioral, and social psychiatric studies of an individual's experiences; thus, it demonstrates how health status at a certain age reflects not only the conditions at that age but also previous living environments (Chittleborough et al., 2006). 'The Notion of Time' is the fundamental feature of the life-course approach, and is the method most suitable for investigating internal responses and changes (D. Kuh et al., 2003; Lynch & Smith, 2005). The importance of the LCA using social environment indices of earlier periods as measurements of SEP has been increased by the recent increased recognition of health inequality (Chittleborough et al., 2006).

According to the LCA, two major conceptual models are suggested to explain the association between previous circumstances and health status in later life: the critical-period model and the accumulation of risk model (Ben-Shlomo & Kuh, 2002). The critical-period model focuses on the significance of timing of exposure, and includes two sub-models: the model with or without later-life risk factors, and that with later-life effect modifiers. The accumulation of risk model emphasizes the significance of exposure during the life course and the sequence of exposure, and the model is separated into 'the model with independent and uncorrelated insults' and 'the model with correlated insults.' Despite this classification, it is difficult to separate the effects of these conceptual models because in real life they are closely interrelated (Rosvall, Chaix, Lynch, Lindström, & Merlo, 2006).

When evaluating the health status of elderly Koreans, several contemporary events must be considered: the Japanese occupation (1910–1945), the Korean War (1950–1953) and the period of rapid industrialization (from the 1960s) (H.-S. Lee, 2006). Elderly Koreans experienced the colonial era and the war during their childhood and adulthood, and rapid economic changes caused by industrialization in their middle age. During the Japanese occupation and the Korean War, the majority of Koreans experienced absolute poverty, resulting in a vicious cycle of lack of education, early marriage, and poverty (H.-S. Lee, 2006); in terms of survival, health is only a secondary concept because survival itself was the most important thing in their childhood, and poverty in childhood meant deprivation of educational opportunities. After experiencing a period of poverty and hunger caused by the war, they assumed the social tasks of industrialization and economic growth (H.-S. Lee, 2006); they worked without sparing themselves in their youth and middle age to

enable national economic development. Thus, their life history is closely related to the historic transitions and background of the country. Life-course studies of elderly Koreans require an in-depth understanding of the senescence formation process that takes into consideration the temporal and spatial factors of Korea. In this regard, applying structured questionnaires based on Western theoretical and cultural perspectives does not reflect the features of elderly Koreans. Therefore, the features of elderly Koreans—such as the aging process and special experiences—can be understood only by studying their life history. Therefore, the LCA can provide important information on the present health status, quality of life, and SEP of the elderly because the differences among individuals are maximized in later life.

The evolution of all biological, social, and behavioral processes occurs over time, which is termed a 'developmental trajectory'. The group-based trajectory model (GBTM) as an alternative approach was developed to compensate for insufficient methods of dividing appropriate subgroups and to share the distinct developmental trajectories within the population. Group-based trajectory analysis provides a statistical standard for establishing the influence of life trajectory (D. S. Nagin, 2005). The life course of older individuals varies with personal experience, and environmental and social gaps accumulate during their life.

This study investigated the association between SRH and SEP over the life course of the Korean elderly population and aimed to provide a unique perspective on the association by trajectory analysis, which is not a comparative analysis of mean values but reflects the characteristics of individuals.

Subjects and Methods

1. Data

The subjects of the present study were randomly allocated by proportional allocation sampling and stratified multi-stage sampling among the 60- to 89-year-old population in South Korea. Sampling was stratified by region, age (60–69, 70–79, and 80–89 years old), and gender according to the following stages. The administrative regions of South Korea consist of seven metropolitan cities and nine provinces. In the first stage, relatively larger, non-adjacent regions were selected in consideration of geographical distribution; thus, four metropolitan cities and three provinces were selected as survey regions. Additionally, each province was divided into urban and rural areas for sampling of various groups of the elderly, resulting in selection of 10 survey regions in total. Island regions that were impossible to survey were excluded.

In the second stage, the gender distribution of the 60- to 89-year-old population was determined in the 10 survey regions based on the population census of 2007. Proportional to the elderly population size, the number of survey sites was assigned to each region; the total number of sites was 100. In each survey region, a number of small administrative population units equal to the number of survey sites were randomly selected. In the final stage, the sample was based on household units; only one person was surveyed when two or more elderly people were living in one household. A registry of the elderly was drawn up with the co-operation of regional senior citizens' associations and village supervisors. Random sampling of the

households in each survey site was conducted until 10 participants were found per 100 sites that reflected the age and gender strata of the survey region. A total of 1000 subjects from 10 survey regions underwent face-to-face interviews, and the survey was conducted by well-trained interviewers from June 24 to July 26 2008. The survey was approved by the institutional review board of Graduate School of Public Health, Seoul National University (No. 2007-12-21-47).

2. Measurements

A draft survey questionnaire was developed by means of in-depth interviews and analysis of publically available data on the elderly to identify exposures in the life course. Based on the results, a draft questionnaire of health status and SEP indicators during the life course was created and a cognitive study and pilot test were conducted to investigate the validity of the developed indicators. The questionnaire that included the indicators was corrected and revised considering the preliminary results.

2.1. Self-rated health

SRH status was measured by a single question: “How would you rate your health status retrospectively every 10 years?” on the following five-point scale: very good (5), good (4), fair (3), bad (2), and very bad (1), and response times varied with the age of the subject. Health status up to the sixth decade of life was used in this study because all subjects could respond to the question until their 60s.

2.2. Explanatory variables during the life course

Life course was divided into childhood and adolescence, adulthood, and senescence. For each stage, variables that reflect SEP were included. In childhood and adolescence, three variables were included: land ownership of a parent at 15 years old, experience of skipping meals, and educational level. Questions related to land ownership and experience of skipping meals were responded to with 'Yes (1)' or 'No (0)'. Educational level is not only a demographic variable; it is also a very important life-course variable that accumulates from early childhood to early adulthood. Educational level was divided into two groups by applying different cutoff values according to gender. The cutoff values were set considering the distribution of education level: (1) middle school or lower, and (2) high school or higher in men, and (1) less than elementary school, and (2) elementary school or higher in women.

The adulthood variable was as follows: the longest occupation. Occupation-related questions were responded to using an open-ended scale and re-coded as numbers according to the Korea Standard Classification of Occupation (KSCO), the Korean version of ISCO-08 (ILO, 2008): (1) manager; (2) professional and related workers; (3) clerks; (4) service workers; (5) sales workers; (6) skilled agricultural, forestry and fishery workers; (7) craft and related trade workers; (8) equipment, machine-operating and assembling workers; and (9) elementary workers. This classification was simplified into four groups in the present study: the white and pink-collar group (1, 2, 3, 4, and 5), blue-collar group (7, 8, and 9), farmer group (6) and housewife group (women only); since the majority of the 'skilled agricultural,

forestry and fishery workers' group was engaged in agriculture, they were referred to as farmers for reasons of convenience.

The two variables in the senescence period were: (a) Basic Livelihood Security recipient, (b) chronic disease status. The study participants were divided into the recipient group and the non-recipient group based on whether they were currently recipients under the Basic Livelihood Security system. The subjects were encouraged to answer the question regarding chronic disease status whether they had received a clinical diagnosis for the following major chronic diseases: hypertension, diabetes, cancer, chronic pulmonary disease, liver disease, cardiac and cerebrovascular disease, and (rheumatoid) arthritis. The subjects were classified into two groups, those with and without chronic diseases.

2.3. Socio-demographic variables

To assess the association between SRH and SEP variables during the life course, possible covariates likely to confound the results were considered. Respondents' age, gender, place of residence, current household income, and marital status were included as covariates. The subjects were divided into two groups according to age: those 60–69 years old and those 70–89 years old. The place of residence was classified into three groups: metropolitan, urban, and rural areas. Current household income represents the current financial state of the elderly and reflects their economic activity over the life course. The income variable was investigated based on 5-million-won units and divided into quintiles. Lastly, marital status was confirmed by combining questions on marriage experience and current

spouse status, and re-coded as ‘married’ or ‘single’.

3. Gender differences in self-rated health

In the previous study on gender differences in SRH among the elderly population (Arber & Ginn, 1993), elderly women evaluated their SRH as worse than did elderly men. There are two prominent explanations of gender differences in health: the differential exposure explanation and the differential vulnerability explanation (Denton, Prus, & Walters, 2004). For these reasons, all analyses used a gender-stratified dataset to examine gender differences.

4. Statistical Analysis

The subjects were examined in terms of their background, socioeconomic status during each stage of the life course, and SRH status by gender. A frequency analysis was conducted to investigate the general characteristics of the subjects. A chi-squared test was performed to examine the differences in explanatory variables according to trajectory group. The subjects were analyzed by gender using the trajectory analysis method. To analyze longitudinal data, the multiple trajectory model was used as a statistical method (D. S. Nagin, 2005). This model involves dividing the study population into groups that have a similar trajectory in the outcome variables in which the researchers are interested. In the group-based trajectory model (GBTM), the population is a mixture of fundamental trajectory groups (B. L. Jones & Nagin, 2007).

The Proc Traj procedure in SAS was used to analyze SRH status for group-based trajectories. The statistical method presumed the following likelihood functions:

$$Y_i = \{y_{i1}, y_{i2}, y_{i3}, \cdots y_{iT}\},$$

which denotes the longitudinal progression of measurements of an individual *i* over *T* periods;

$$P(Y_i) = \sum \pi_j P^j(Y_i)\, P(Y_i)$$

is the probability of Y_i having membership of group *j*, and π_j is the probability of group *j*. The form of $P(Y_i)$ is decided according to the type of latent variables used in the analysis (B. L. Jones & Nagin, 2007; B. L. Jones, Nagin, & Roeder, 2001). The censored normal model was selected because SRH status is a psychometric scale. SRH status was modeled with a normal distribution, and the censored normal model assumed the following:

$$Self-rated\ \ health_{it}^{*j} = \ \beta_0^j + \ \beta_1^j Time_{it}^1 + \ \beta_2^j Time_{it}^2 + \ \beta_3^j Time_{it}^3 + \varepsilon_{it}.$$

Bayesian information criteria (BIC) were calculated and compared to determine the optimal number of groups (D. S. Nagin, 2005; Daniel S Nagin & Odgers, 2010; Daniel S Nagin & Tremblay, 1999). After the optimal number for both genders had been determined to be three, a multinomial analysis was conducted to investigate the association between SEP variables and SRH trajectories. All analyses were performed using SAS statistical software, version 9.4 (SAS Institute, Inc., Cary, NC).

Results

Table 2.1 shows the descriptive characteristics of the study subjects by gender. The majority of the study participants resided in urban areas: 40% in metropolitan areas and 11% in rural communities. Most were in their 60s (65.0% of men and 54.1% of women). Among elderly men, the cutoff value of education level was middle school graduation, and the number of subjects in the group with a lower education level was slightly higher. In the case of elderly women, the most common level of education was less than elementary school graduation (41.0%). Most of the elderly men had spouses, whereas the majority of the elderly women were single. The number of elderly whose families owned land at the time the interviewee was 15 years old was more than twice that of those who did not in both genders. The number of elderly who had skipped meals in childhood was less than half of the number who had not. The main longest-duration occupation category among men was white and pink-collar work, while one-third of women had engaged in agriculture. About 5–6% of both men and women were recipients of Basic Livelihood Security. More than twice as many women had chronic diseases than did not, but no notable difference was observed among the elderly men (Table 2.1).

Table 2.1. Descriptive characteristics of study populations (N=1,000)

Characteristics	Men (*n*=431)		Women (*n*=569)	
	n	(%)	*n*	(%)
Age				
60-69	280	(64.97)	308	(54.13)
70-89	151	(35.03)	261	(45.87)
Region				
Rural	47	(10.9)	71	(12.48)
Urban	205	(47.56)	277	(48.68)
Metropolitan	179	(41.53)	221	(38.84)
Education level				
Less than elementary school	51	(11.83)	233	(41.95)
Elementary school	92	(21.35)	174	(30.58)
Middle school	89	(20.65)	74	(13.01)
High school	112	(25.99)	62	(10.90)
College or higher	87	(20.19)	26	(4.57)
Household income				
Q1	41	(9.51)	103	(18.1)
Q2	162	(37.59)	173	(30.4)
Q3	45	(10.44)	57	(10.02)
Q4	97	(22.51)	130	(22.85)
Q5	86	(19.95)	106	(18.63)
Marital status				
Single	65	(15.08)	309	(54.31)
Married	366	(84.92)	260	(45.69)
Land ownership at 15 years old				
Yes	317	(73.55)	394	(69.24)
No	114	(26.45)	175	(30.76)
Experience of skipping meals				
Yes	131	(30.39)	158	(27.77)
No	300	(69.61)	411	(72.23)
The longest occupation				
White & Pink-collar	191	(44.52)	150	(26.36)
Blue-collar	125	(29.14)	62	(10.9)
Farmer	113	(26.34)	188	(33.04)
Housewife	-	-	169	(29.7)
Basic Livelihood Security recipient				
Yes	25	(5.83)	37	(6.53)
No	404	(94.17)	530	(93.47)
Chronic disease				
Yes	235	(54.52)	411	(72.49)
No	196	(45.48)	156	(27.51)

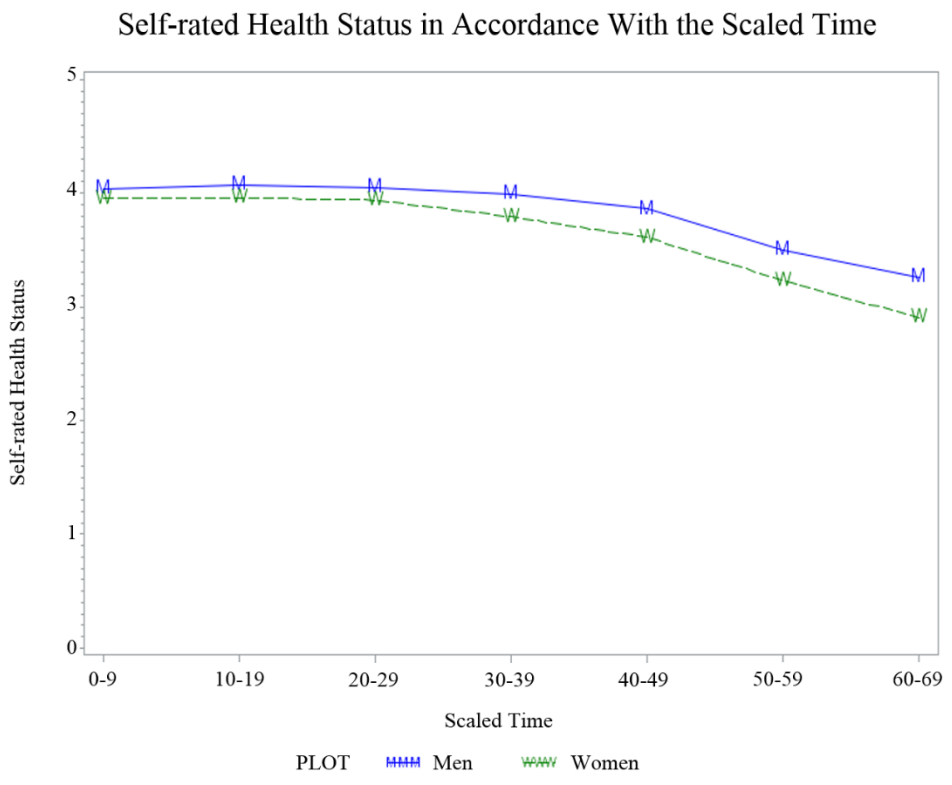

Figure 2.1. The change of self-rated health status in accordance with the scaled time

SRH tended to decrease slightly with increasing age, and the degree of decrease was slightly greater in elderly women than in elderly men (Figure 2.1). As shown in Fig. 1, women showed lower self-rated health trajectories throughout their life course. Both men and women experienced declining SRH with increasing age. A linear regression model showed that the decline in SRH with age was significantly faster in women than in men, as indicated by a statistically significant interaction (data not shown). Trajectory plots differed markedly depending on gender (Figures 2.2 and 2.3). The intervals among the three groups in SRH trajectories were as follows: (1) lowest, (2) middle, and (3) highest, and were relatively constant in elderly men (Figure 2.2). In elderly women, the trajectory membership was divided into three groups: (1) lowest, (2) health declining, and (3) highest, and the SRH status of the middle group decreased rapidly, unlike the equivalent group in elderly men (Figure 2.3).

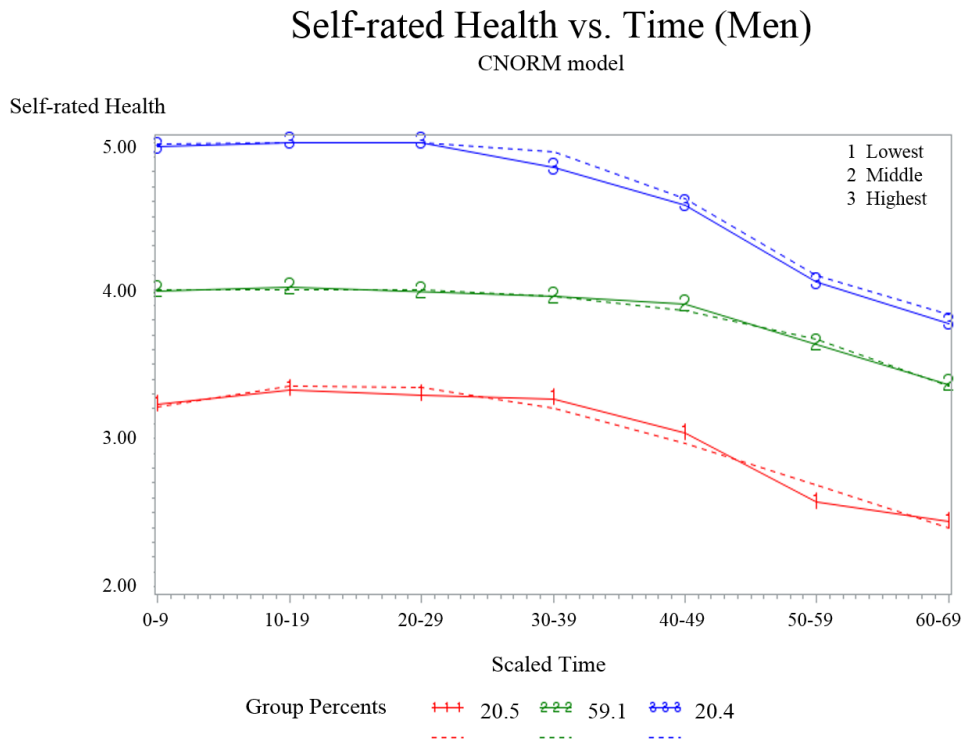

Figure 2.2. Trajectories of self-rated health in the elderly men

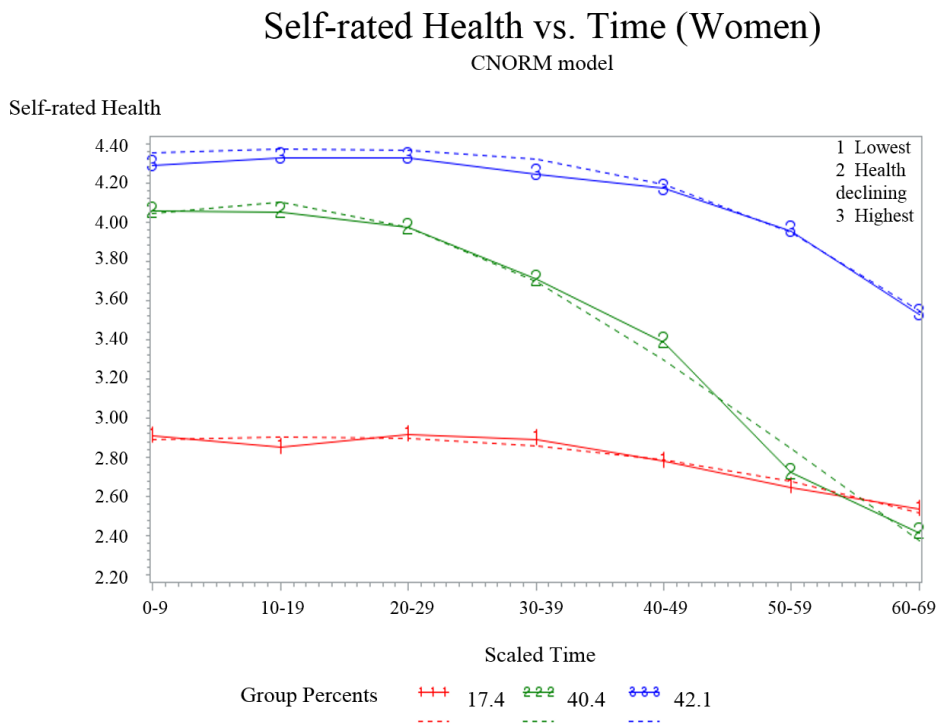

Figure 2.3. Trajectories of self-rated health in the elderly women

Table 2.2 shows the differences in the distribution of the explanatory variables according to trajectory group. The distribution of income quintiles in both genders was significantly different depending on the trajectory group. That is, the percentage of the subjects belonging to the lower quartile held a higher rank in the lowest trajectory group, while the percentage of the subjects with a higher income was higher in the other trajectory groups. In addition, statistically significant differences were found in the other three variables regardless of gender: experience of skipping meals, being a recipient of Basic Livelihood Security, and chronic disease. In other words, the highest trajectory group had a lower probability of a negative experience and national support, and were healthier compared to the lowest and middle trajectory groups.

Tables 2.3 and 2.4 show the odds ratios of the differences in SEP variables across SRH trajectories according to gender. In elderly men (Table 2.3), those with experience of skipping meals in their childhood (OR = 2.98) and those with chronic disease conditions (OR = 3.74) were more likely to be a member of the lowest than the highest trajectory group. The elderly men in the middle trajectory group were more likely than those in the highest trajectory group to have a chronic disease (OR = 1.96).

Table 2.4 shows the results for elderly women: those with experience of skipping meals were more likely to be in the lowest (OR = 1.95) than the highest trajectory group. Also, the elderly women in the lowest trajectory group were more likely to be housewives than other employment groups (ORs = 0.47, 0.31, and 0.42). Higher household income decreased the likelihood of elderly women being in the

declining-health group (OR = 0.85). The elderly women in the declining-health group were more likely to be recipients of Basic Livelihood Security (OR = 2.67). Those with chronic disease were more likely to be in the lower trajectory group (OR = 2.35 and 2.75) than the higher trajectory group.

Table 2.2. The characteristics of self-rated health trajectory according to gender

Characteristics	Men (*n*=431)				Women (*n*=569)			
	Lowest (*n*=93)	Middle (*n*=252)	Highest (*n*=86)	*p-value***	Lowest (*n*=99)	Health Declining (*n*=238)	Highest (*n*=232)	*p-value***
Age								
60-69 years old	64.4	64.3	67.4	0.862	50.5	54.7	55.1	0.726
70-89 years old	35.6	35.7	32.6		49.5	45.3	44.9	
Region								
Rural	8.9	10.7	13.5	0.889	7.1	16.2	11.0	0.130
Urban	50.0	47.6	44.9		55.6	46.6	47.9	
Metropolitan	41.1	41.7	41.6		37.4	37.2	41.1	
Education level*								
Lower	58.9	53.2	50.6	0.508	47.5	42.7	36.4	0.133
Higher	41.1	46.8	49.4		52.5	57.3	63.6	
Household income								
Q1	18.9	6.4	9.0	0.015	14.1	23.5	14.4	0.028
Q2	40.0	36.9	37.1		37.4	30.8	27.1	
Q3	5.6	11.5	12.4		7.1	10.3	11.0	
Q4	22.2	21.4	25.8		24.2	21.8	23.3	
Q5	13.3	23.8	15.7		17.2	13.7	24.2	
Marital status								
Single	21.1	12.7	15.7	0.157	37.4	46.2	48.7	0.161
Married	78.9	87.3	84.3		62.6	53.9	51.3	
Land ownership at 15 years old								
Yes	65.6	75.8	75.3	0.154	62.6	69.2	72.0	0.235
No	34.4	24.2	24.7		37.4	30.8	28.0	
Experience of skipping meals								
Yes	45.6	28.6	20.2	0.001	35.4	31.6	20.8	0.006

Table 2.2. (*continued*)

No	54.4	71.4	79.8		64.7	68.4	79.2	
The longest occupation								
White & Pink-collar	44.3	43.7	47.2	0.969	23.2	23.5	30.5	0.062
Blue-collar	30.7	29.0	28.1		7.1	12.0	11.4	
Farmer	25.0	27.4	24.7		28.3	37.2	30.9	
Housewife					41.4	27.4	27.1	
Basic Livelihood Security recipient								
Yes	13.3	3.6	4.5	0.003	10.1	8.6	3.0	0.014
No	86.7	96.4	95.5		89.9	91.4	97.0	
Chronic Disease								
Yes	70.0	54.4	39.3	0.000	78.8	80.7	61.7	<.0001
No	30.0	45.6	60.7		21.2	19.3	38.3	

*The cutoff values were applied differently by gender. Men: middle school or lower as the lower group, and high school or higher as the higher group, Women: less than the elementary school as the lower group, and elementary school or higher as the higher group

**p-values were calculated by χ^2 test

Table 2.3. The odds ratios of socioeconomic position variables in life course to self-rated health trajectory in the elderly men by multinomial logistic regression

	Lowest		Middle	
Variables	OR	*p-value*	OR	*p-value*
Age (70-89 vs. 60-69 years old)	0.79	0.522	1.04	0.893
Region				
Rural vs. Metropolitan	0.53	0.310	0.64	0.355
Urban vs. Metropolitan	0.91	0.791	1.08	0.792
Education level (Higher vs. Lower)	0.99	0.983	0.97	0.928
Household income	0.95	0.690	1.19	0.120
Marital status (Single vs. Married)	0.96	0.935	0.70	0.342
Land ownership at 15years old	0.68	0.290	1.03	0.936
Experience of skipping meals	2.98	0.004	1.65	0.124
The longest occupation				
White &Pink-collar vs. Farmer	0.96	0.935	0.67	0.319
Blue-collar vs. Farmer	0.80	0.652	0.81	0.582
Basic Livelihood Security recipient	1.73	0.430	0.86	0.819
Chronic disease	3.74	<.0001	1.96	0.012

OR: Odds Ratio.

Table 2.4. The odds ratios of socioeconomic position variables in life course to self-rated health trajectory in the elderly women by multinomial logistic regression

	Lowest		Health declining	
Variables	OR	*p-value*	OR	*p-value*
Age (70-89 vs. 60-69 years old)	0.73	0.297	0.83	0.406
Region				
Rural vs. Metropolitan	0.69	0.502	1.19	0.641
Urban vs. Metropolitan	1.17	0.592	0.95	0.826
Education level (Higher vs. Lower)	0.93	0.823	1.26	0.350
Household income	0.96	0.711	0.85	0.041
Marital status (Single vs. Married)	1.66	0.088	0.97	0.880
Land ownership at 15years old	0.67	0.138	0.81	0.351
Experience of skipping meals	1.95	0.025	1.51	0.086
The longest occupation				
White &Pink-collar vs. Housewife	0.47	0.023	0.83	0.483
Blue-collar vs. Housewife	0.31	0.019	0.88	0.706
Farmer vs. Housewife	0.42	0.019	0.89	0.705
Basic Livelihood Security recipient	2.88	0.058	2.67	0.042
Chronic disease	2.35	0.005	2.75	<.0001

OR: Odds Ratio.

Discussion

This cross-sectional study confirmed the SRH trajectory of the Korean elderly population and related factors in their life course by means of a retrospective questionnaire. Using a group-based trajectory model, three types of SRH trajectory and different gender patterns were found. In men, health status typically decreased with age, in three parallel trajectory groups: highest-middle-lowest. In contrast, the 'declining' health group, which exhibited a drastic decrease in health status, was found only in women; almost 40% of the older women were included in this group. A low socioeconomic status and chronic disease during their lifetime were the main factors associated with an increased likelihood of belonging to the health-declining group.

Experience of skipping meals and chronic disease differed among the SRH trajectory groups in both men and women. Additionally, when determining group affiliation, household income and the longest-duration occupation were associated only in women. Experience of skipping meals was an indicator of malnutrition. Undernutrition in childhood resulted in a lower health status in later life; this is in agreement with the previous studies (Da Li et al., 2012; DeBoer et al., 2012; Osmond, Kajantie, Forsén, Eriksson, & Barker, 2007). The stunting caused by nutritional deficit and enteric inflammation in childhood is related to a high risk of metabolic syndrome in adulthood (DeBoer et al., 2012). Moreover, failure to thrive in childhood owing to undernutrition increases the risk of stroke (Osmond et al., 2007) and stomach cancer (Da Li et al., 2012). Consistent with the previous studies (Cott, Gignac, & Badley, 1999; Hoeymans, Feskens, Kromhout, & van den Bos, 1999;

Molarius & Janson, 2002; Moussavi et al., 2007; Theme-Filha, Szwarcwald, & Souza-Júnior, 2005), negative physical conditions such as chronic diseases or long-term disability affected SRH; thus, individuals with one or more chronic diseases had a lower SRH status than those who did not.

Gender differences in health trajectory may have complex causes, including different distributions and/or sensitivities of risk factors according to gender. Among older women, housewives were more likely to belong to the lowest health trajectory group compared to all other occupational groups. Although a previous study suggested that paid employment is negatively associated with women's health (Arber, Gilbert, & Dale, 1985), it is widely accepted that the employed have better health status than housewives (Anson & Anson, 1987; Artazcoz, Borrell, Benach, Cortès, & Rohlfs, 2004; Bardage et al., 2005; Roos, Burström, Saastamoinen, & Lahelma, 2005). Occupation is a productive activity that generates household income, but it is also one way to reach self-realization. Older women who had a low income were more likely to be in the poor SRH group than in the excellent SRH group. People with a relatively low income have lower health status than those with the highest income in terms of both physical function and mental health (Cott et al., 1999; Franks, Gold, & Fiscella, 2003). In addition, the association between SRH and the Basic Livelihood Security system can be explained in a similar context to that of household income. Poverty restricts access to healthcare resources, resulting in lower health status. Therefore, an appropriate creation of employment that reflects the longest-duration career will entrench economic stability. In addition, economic stability in old age is required and should be guaranteed since an appropriate level of economic security contributes to maintenance of a healthy mind and body.

The previous studies have suggested that older age and lower education level are associated with poor SRH (B. P. Kennedy, Kawachi, Glass, & Prothrow-Stith, 1998; Laaksonen, Rahkonen, Martikainen, & Lahelma, 2005; Molarius et al., 2007; Subramanian, Kim, & Kawachi, 2005). This study compared two generations; those aged 60–69 and those aged 70–89 years at the time of the survey. In both generations, SRH generally declined with increasing age. However, according to multinomial models, those aged 60–69 years did not necessarily show a higher SRH trajectory over their life course compared to the older generation in both genders. Generally, the younger generation might be expected to have a better health trajectory as the society is developed. However, it is noteworthy that the younger generation spent their early childhood during the Korean War, suffering from more severe famine than occurred during the Japanese occupation (C.-H. Lee, Joo, Ahn, & Ryu, 1988). In particular, malnutrition in early childhood exerts more negative effects on health status compared to exposure in late childhood or adulthood (Elias, van Noord, Peeters, den Tonkelaar, & Grobbee, 2003; van Abeelen et al., 2012).

In general, people with a higher education level are more likely to have good SRH (Subramanian et al., 2005). In the present study, the education levels of men were relatively evenly distributed, while the majority of women were uneducated. Thus, to categorize education into two groups, different cut-off values were applied according to gender; as a result, the subjects with a higher education level were less likely to be in the lower trajectory group. However, the effect size and statistical power were decreased following adjustment for various explanatory variables. This tendency is similar to those studied previously (Gilmore, McKee, &

Rose, 2002; Molarius et al., 2007; Shields & Shooshtari, 2001; Szwarcwald, Souza-Júnior, Esteves, Damacena, & Viacava, 2005).

The longest-duration occupation had no association with SRH in elderly men. Farmers, who comprised the highest percentage as a single occupation category in men, were the reference group, but no statistical significance of occupation was found. However, despite the lack of statistical power, the SRH of elderly men engaged in agriculture was worse than that of all other occupational groups. This result is consistent with the previous studies of the negative effects of agriculture on a variety of health conditions, including SRH (Yesalis, Lemke, Wallace, Kohout, & Morris, 1985; Zimmer & Amornsirisomboon, 2001).

The strength of the present study lies in the analysis of various socioeconomic variables that affect each stage of the life course. This is the first study to show the feasibility of generalizing the results of quantitative research using the LCA. Few qualitative studies (Han, 2004; E. Kang & Han, 2002; H.-S. Lee, 2006) have focused on this issue to date. In terms of statistical method, patterns of trajectories cannot be identified by simple comparisons of mean values (as used in traditional statistical methodologies) because the trajectories vary throughout the life course.

The traditional methods of analysis of developmental trajectories at the individual level are the multilevel and latent curve models (MacCallum, Kim, Malarkey, & Kiecolt-Glaser, 1997). These two models involve different statistical assumptions, but both are based on the mean and covariance matrix (MacCallum et al., 1997; Muthén & Curran, 1997; D. S. Nagin, 2005). These methods do not enable comparison and categorization of the health trajectories of the elderly. For example,

SRH in elderly women can be divided into high and low groups at a certain time. However, the poor SRH group comprises both individuals with a continuously lower SRH and those in whom SRH declines rapidly. In other words, the poor SRH group is not only heterogeneous but also has different life histories; these findings can be obtained by GBTM but not using traditional analytical methods. In addition, identifying health problems and their trajectories in the elderly can assist how to formulate the health policies and healthcare services for the elderly. That is, different interventions should be applied according to the characteristics of the groups.

I have presented an initial description of health trajectories and their associated factors among older adults in Korea. Several issues should be considered when interpreting the results. The present study was cross-sectional, so recall of earlier life situations might have been incomplete. A longitudinal study would enable further elucidation of the link between life-course socioeconomic risk factors and health trajectory, and would allow stronger causal inferences to be made. In addition, the self-developed questionnaire for socio-economic conditions during the life course has not been validated using any gold standard and has not been tested in relation to objective indicators. A questionnaire developed in other countries could have been applied; however, the historical and cultural background of the older population in each societal context should be considered.

This study has several policy implications. First, poor health from early life may be due to exposure to adverse environments during childhood. Chronic disease in the adult period is strongly associated with continued poor health or even worsened health status. Efforts to prevent chronic diseases are crucial for this group.

For women, appropriate occupational participation may be beneficial. Second, there is a distinct group (especially among women) whose health status declines sharply during adult life. This group is characterized by the combination of poverty and chronic disease. Social security as well as chronic disease prevention is important to minimize this decline in health status. Third, public policy needs to be established to protect children from adverse exposures, particularly if the family cannot afford such protection. Such a policy is highly valuable as its effect may be lifelong. Finally, it is important to monitor socioeconomic determinants of health over the life course. The impact of such exposures may influence health throughout the life course up to the elderly stage. Early interventions to mitigate the effect of adverse exposures can reduce the burden of population aging and contribute to improved health in the adult and elderly periods of life.

In conclusion, diverse health trajectories of Korean older population were identified and the effect of exposures during the life course on health status were explored by GBTM. The present study implies that the elderly form various health trajectories during their life course and different health trajectories people experienced over the life course requires different approaches to health promotion. More specifically, it is necessary to identify the current health status of the elderly who have undernourished during childhood and to plan ways to reduce the health inequality caused by experiences of skipping meals because undernourished childhood as a major risk factor of poor health status and the childhood that has already passed cannot be reversed. In addition, the results of this study suggest that the LCA enables accurate evaluation of determinants of health status in later life; thus, further studies of all of the biological, behavioral, and socio-psychological

aspects are warranted.

CHAPTER III.

Gender Differences in the Trajectories and the Risk Factors of Depressive Symptoms in Later Life

Introduction

Depression is one of the most significant mental disorders associated with later life. In Korea, approximately one-third of elderly individuals suffer from depressive symptoms (Korea Labor Institute, 2009), much more frequent compared to the longitudinal studies using similar survey methods. The prevalence of depressive symptoms was found to be 14.6% in the Health and Retirement Study (HRS), 17.6% in the English Longitudinal Study of Ageing (ELSA) (Zivin et al., 2010), and 10% in the Irish Longitudinal Study of Ageing (TILDA) (Barrett et al., 2011). Depression has a negative effect on physical health and may even result in suicide in extreme cases. The association between depression and suicide is well documented. Several meta-analyses have found that various depressive disorders, including major depressive disorders, depressive symptoms, and depressive episodes, are strongly associated with the risk of suicide (Harris & Barraclough, 1997; Yoshimasu, Kiyohara, Miyashita, & Hygiene, 2008). A recent Organisation for Economic Co-operation and Development (OECD) report described that the age-standardized suicide rate among the elderly in South Korea was 72 per 100,000 population, which was more than three times higher than the OECD average of 22 (OECD, 2011). Thus, the prevention of depression, a major risk factor of suicide, is important to remove the stigma associated with the 'Republic of Suicide.'

Depression in the elderly is often accompanied by cognitive impairments, such as dementia, and this may be referred to as pseudo-dementia (Kiloh, 1961). Pseudo-dementia describes the clinical manifestation of cognitive issues that are similar to, but are not true, dementia and is primarily associated with geriatric

depression (H. Kang et al., 2014; Kiloh, 1961). Additionally, meta-analytic research has identified a positive correlation between depression and dementia such that depression is a risk factor of dementia (Diniz, Butters, Albert, Dew, & Reynolds, 2013). Therefore, the screening for and treatment of depression can lead to significant reductions in the socioeconomic costs related to dementia. In this regard, depression is not only a matter of mental health but of the overall health of individuals because it has a significant effect on physical health. Owing to the rapid aging of South Korean society, the proportion of elderly in this country will continue to increase. This phenomenon may result in greater social problems if not dealt with adequately. Therefore, identifying factors that affect depression in the elderly is crucial for the development of appropriate interventions.

The gender differences in the incidence and severity of depressive symptoms are well documented. For example, one study clearly concluded that women are more likely to be depressed than men (Nolen-Hoeksema, Larson, & Grayson, 1999). However, the factors that determine this difference vary from study to study and from population to population. For example, elderly South Korean women are unable to live independent lives against the historical background in which the patriarchal ideology of a patrilineal society prevails (E. Kang & Han, 2002). As a result, they do not have a high priority in the allocation of limited family resources in times of war and poverty (E. Kang & Han, 2002; H.-S. Lee, 2006). Because the effects of contemporary and cultural backgrounds impact the elderly differently according to gender, it is important to identify the factors that affect depression in accordance with gender.

Longitudinal studies are conducted to determine changes in phenomena over time. This type of study design can be used to empirically demonstrate a causal association. Despite the strengths of this design, there are difficulties associated with establishing appropriate criteria for the categorization of meaningful subgroups in terms of patterns of change. Group-based trajectory modeling (GBTM) could be a useful solution to this problem. This model determines inclusion in a subgroup by classifying individuals based on similar patterns of change in interesting variables among the target population (D. S. Nagin, 2005). A trajectory analysis exploratively determines the changing patterns of health status that actually exist. In this regard, it reflects the reality of health status in the elderly more accurately than other methods. Thus, the present study examined the various patterns in the trajectories of depressive symptoms that reflected personal characteristics using GBTM and aimed to identify the factors that influence these patterns according to gender.

Subjects and Methods

1. Data

All data evaluated in the present study were obtained from the baseline (2006) through fourth wave (2012) surveys of the Korean Longitudinal Study of Ageing (KLoSA). This survey was designed to produce basic data needed to develop and implement effective social and economic policies that reflect the aging trends in South Korea. The basic survey was conducted biennially following the baseline survey (2006). The KLoSA population was composed of South Korean adults aged 45 years and older living in households that were selected using stratified multi-stage sampling in order to ensure national representativeness. The baseline survey (2006) included a total of 10,254 individuals who were interviewed using Computer-Assisted Personal Interviewing (CAPI). The second wave survey (2008) followed up 8,688 subjects (retention rate of the original population: 86.6%), the third wave survey (2010) followed up 7,920 subjects (retention rate of the original population: 80.3%), and the fourth wave survey (2012) followed up 7,486 subjects (retention rate of the original population: 76.2%).

Based on the research purposes of the present study, the subjects assessed here were limited to an older population; thus, subjects under the age of 60 (n = 4,706) who completed the baseline survey were excluded. Additionally, subjects who did not complete the interviews until the fourth wave due to loss to follow-up or death (n = 736), those who had taken antidepressants at least once (n = 93), and those with incomplete information related to depressive symptoms from at least one wave of

the surveys (n = 1,052) were excluded from the analyses. In particular, the subjects using antidepressant skipped the question of CES-D according to the survey protocol of KLoSA. Thus, 3,667 individuals (1,566 men and 2,101 women) were ultimately included in the present analyses. This study was approved by the Institutional Review Board of Seoul National University (IRB No. E1608/003-007).

2. Variables

2.1. Depressive symptoms

Depressive symptoms were measured with the Korean version of the 10-item Center for Epidemiological Studies Depression Scale (CES-D 10), a briefer version of the CES-D used worldwide. The CES-D was developed for epidemiological studies investigating depressive symptoms among the general population (Radloff, 1977). The CES-D 10 consists of 10 questions included in the original version: "I was bothered by things that usually don't bother me," "I had trouble keeping my mind on what I was doing," "I felt depressed," "I felt that everything I did was an effort," "I felt pretty good," "I felt fearful," "My sleep was restless," "I was generally satisfied," "I felt lonely," and "I could not get going" (Irwin, Artin, & Oxman, 1999). Each item was measured using a four-point scale that reflects the severity of depressive symptoms in accordance with the frequency of each symptom during the past week: 0 (less than 1 day), 1 (1–2 days), 2 (3–4 days), and 3 (5–7 days).

In the present study, the responses were re-coded as 0 (less than 1 day) and

1 (1 or more days); scores for positive questions such as “I felt pretty good” and “I was generally satisfied” were re-coded in the reverse manner. The total sum of the 10 items was used as a dependent variable and higher scores indicated more severe depressive symptoms. The Cronbach α coefficients for the CES-D 10 in each survey year were 0.80 (2006), 0.80 (2008), 0.82 (2010), and 0.85 (2012), which revealed similar or higher levels of internal consistency compared with a preceding study (0.80) (Irwin et al., 1999).

2.2. Explanatory variables at baseline

To determine the variables that influenced the types of the trajectories of depressive symptoms, possible explanatory variables such as age, education, economic activity, household income, marital status, chronic diseases, pain, social activity, alumni meetings, self-rated health (SRH), disability, and quality of life (QoL) were assessed; these variables were identified in a previous meta-analysis (Kim & Sohn, 2005). Age was included as a continuous variable. The level of education was divided into two groups: middle school or lower and high school or higher. The subjects were also classified as employed or unemployed according to their current employment status. Annual household income during the past year was determined using an open-ended question and then categorized into quartiles, and marital status was categorized as married or single.

The subjects were also asked whether they had been diagnosed with a major chronic disease such as hypertension, diabetes, cancer, chronic pulmonary disease,

liver disease, cardiac disease, cerebrovascular disease, and/or arthritis (degenerative or rheumatoid arthritis); people with one or more chronic diseases were classed as chronic disease patients. The subjects were asked whether they had pain in various parts of their body including the head, shoulders, arms, wrists, fingers, chest, abdomen, waist, hips, legs, knees, ankles, and/or toes; individuals with pain in one or more parts were included in the pain group. The subjects answered "Yes" (1) or "No" (0) to the questions about their social participation in various communities including social gatherings and school, hometown, or family reunions. Self-rated health (SRH) was measured on a five-point scale (very bad, bad, fair, good, and very good) and the subjects were grouped into three categories: poor (1), fair (2), and good (3). Disability questions were only answered if the subject had been diagnosed with a disability by a doctor. Quality of life (QoL) was assessed by asking the subjects whether they were satisfied with their overall QoL compared to others of the same age using a scale from 0 to 100; the scores were divided into deciles.

3. Statistical analysis

Non-weighted frequencies, means, and standard deviations (SDs) were calculated for the explanatory variables according to gender to examine the general characteristics of the study population. There were significant differences in the distributions of almost all of the variables according to gender and thus, the population was analyzed according to gender.

Various subsamples were analyzed using the GBTM, which was developed

to cluster subjects who share similar trajectories over time in terms of the outcome variables (D. S. Nagin, 2005). From the perspective of the GBTM, the study population is a mixture of basic trajectory groups. This model can only be applied to longitudinal studies that repeatedly measure an individual at several time points; subsequently, the model can be used to calculate the probability that an individual belongs to a specific group (D. S. Nagin, 2005). In the GBTM, the model selection depends on the type of outcome variables used in the analysis and each individual is assigned to the trajectory group that shows the highest probability of membership. In the present study, the censored normal model was selected because it was considered more adequate for an ordinal psychometric scale (B. L. Jones et al., 2001).

The PROC TRAJ procedure, an add-in module in the SAS program, was used to analyze the depressive symptoms in the subjects. The Bayesian information criteria (BIC) value was calculated and then compared to determine the optimal number of groups with the principle of parsimony (D. S. Nagin, 2005). After the optimal numbers were determined for men (4) and women (5), the weighted proportions, means, and SDs of the covariates were computed according to the trajectories of depressive symptoms to compare the differences among the trajectories. Finally, a multinomial analysis was conducted to investigate the associations between explanatory variables at baseline and the trajectories of depressive symptoms for both genders. All analyses were performed using SAS statistical software, version 9.4 (SAS Institute, Inc.; Cary, NC).

Results

Table 3.1 presents the descriptive statistics of the study population according to gender; there were considerable differences based on gender for most variables. The mean age was higher in women (69.5 years) than in men (68.4 years). Women were more likely to have a lower level of education than men, such that the majority of women had a middle school education or lower. Approximately 75% of women were unemployed, whereas approximately 40% of men were employed. In addition, more than 90% of men retained a married status, while approximately 42% of women were single. Women also suffered more from pain than men, and 87% of women had one or more types of pain. Men appeared to be more active in terms of social participation, such as attending social gatherings and school/hometown/family reunions. The percentage of women with poor SRH was much higher than that of men, and, in particular, approximately 50% of women had poor SRH. Additionally, the average QoL appeared to be higher in men.

The different trajectories of depressive symptoms according to gender are presented in Figures 3.1 and 3.2; the scaled time represents the survey wave (1 = 2006, 2 = 2008, 3 = 2010, and 4 = 2012). Figure 3.1 illustrates the various trajectories of depressive symptoms in men, who were divided into four groups: normal (1), mild depressed (2), worsening (3), and depressed (4). Women exhibited the same pattern as men except that a distinctive group showed improvements in depressive symptoms; thus, the women were partitioned into five groups: normal (1), mild depressed (2), worsening (3), improving (4), and depressed (5; Figure 3.2).

Table 3.1. General characteristics of study populations (N=3,667)

	Men (n=1,566)		Women (n=2,101)	
Variables at baseline	*n*	(%)	*n*	(%)
Age, Mean ± SD	68.39 ± 6.02		69.53 ± 6.67	
Education				
Middle school or lower	989	(63.2)	1926	(91.7)
High school or higher	577	(36.9)	175	(8.3)
Economic activity				
Unemployed	964	(61.6)	1806	(86.0)
Employed	602	(38.4)	295	(14.0)
Household income				
Q1	458	(29.3)	790	(37.6)
Q2	548	(35.0)	661	(31.5)
Q3	318	(20.3)	369	(17.6)
Q4	242	(15.5)	281	(13.4)
Marital status				
Single	109	(7.0)	888	(42.3)
Married	1457	(93.0)	1213	(57.7)
Chronic disease				
Yes	836	(53.4)	1398	(66.5)
No	730	(46.6)	703	(33.5)
Pain				
Yes	918	(58.6)	1834	(87.3)
No	648	(41.4)	267	(12.7)
Social gathering				
Yes	904	(57.7)	932	(44.4)
No	662	(42.3)	1169	(55.6)
Reunions				
Yes	387	(24.7)	90	(4.3)
No	1179	(75.3)	2011	(95.7)
Disability				
Yes	141	(9.0)	121	(5.8)
No	1425	(91.0)	1980	(94.2)
SRH				
Poor	445	(28.4)	1026	(48.8)
Fair	563	(36.0)	688	(32.8)
Good	558	(35.6)	387	(18.4)
QoL, Mean ± SD	5.28 ± 2.71		4.76 ± 2.77	

SD: Standard deviation, SRH: Self-rated Health, QoL: Quality of Life

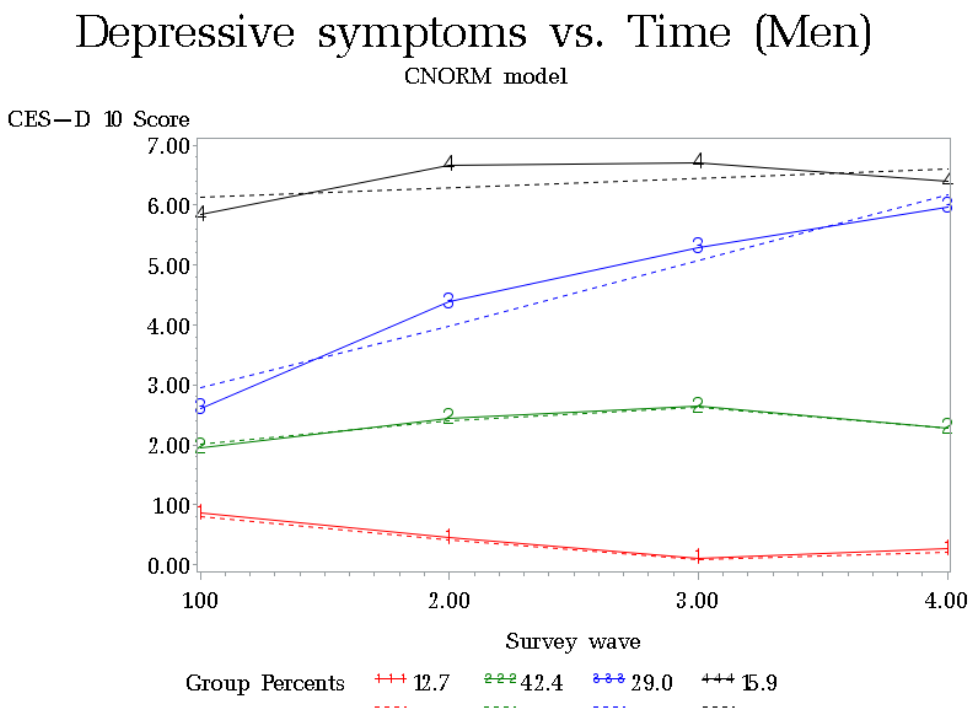

Figure 3.1. Trajplot indicates the changes of CES-D 10 score as index of depressive symptoms in elderly men. The scaled time represents the survey wave (1 = 2006, 2 = 2008, 3 = 2010, and 4 = 2012).

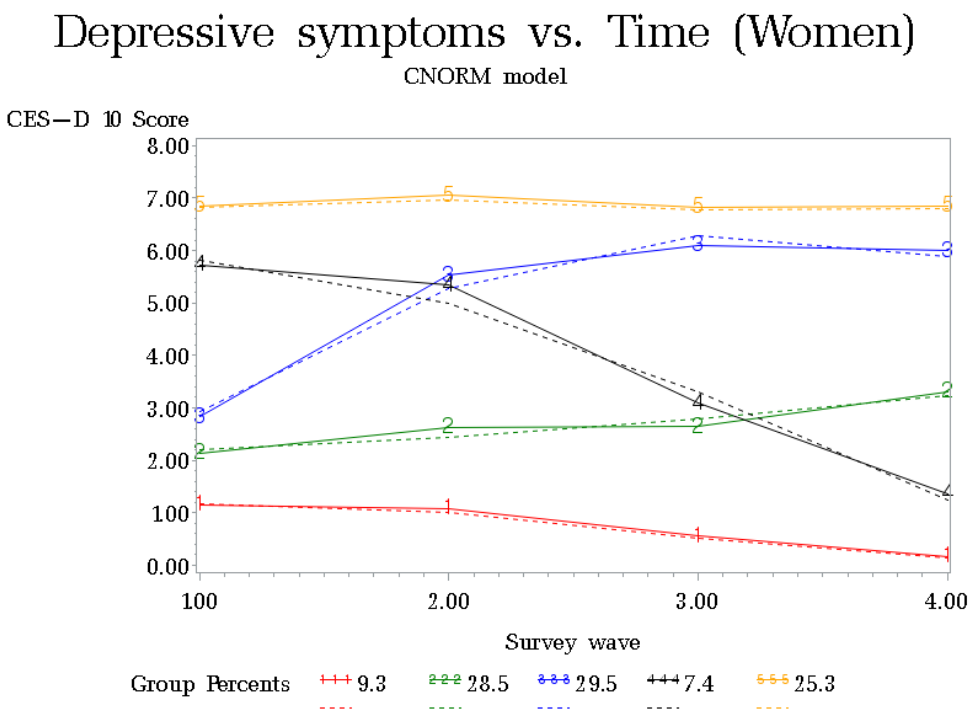

Figure 3.2. Trajplot indicates the changes of CES-D 10 score as index of depressive symptoms in elderly women. The scaled time represents the survey wave (1 = 2006, 2 = 2008, 3 = 2010, and 4 = 2012).

Table 3.2 details the statistically significant differences in almost every explanatory variable according to the trajectories of depressive symptoms. The characteristics according to the trajectory groups were similar in both genders. The depressed group was the oldest, had the highest percentage of a lower level of education, had a lower household income, and had a lower marriage rate than the other groups. The normal group had lower percentages of chronic disease, pain, and disability, higher percentages of social participation at social gatherings and reunions, and a higher proportion of subjects with good SRH. Conversely, the proportion of subjects with poor SRH was high in the depressed group.

Tables 3.3 and 3.4 provide the odds ratios (OR) used to determine differences in the explanatory variables across trajectories according to gender. Elderly men who were unmarried (OR = 2.19), had poor SRH (OR = 0.77), and/or had lower QoL (OR = 0.91) were more likely to be in the mild depressed group than in the normal group. Men in the worsening group were more likely to be older (OR = 1.05), suffer from pain (OR = 1.49), be absent from various reunions (OR = 0.66), had poor SRH (OR = 0.70), and/or had lower QoL (OR = 0.87) than men in the normal group. A comparison of the normal and depressed groups revealed that older age (OR = 1.07), unemployment (OR = 0.53), pain (OR = 2.01), poor SRH (OR = 0.36), and/or lower QoL (OR = 0.70) increased the likelihood of elderly men being in the depressed group (Table 3.3).

Elderly women with a higher level of education (OR = 1.78), pain (OR = 1.57), nonattendance at reunions (OR = 0.50), and/or lower QoL (OR = 0.92) were more likely to be included in the mild depressed group than in the normal group.

Women in the worsening group were more likely to be older (OR = 1.04), have pain (OR = 2.29), be absent from reunions (OR = 0.44), and/or have lower QoL (OR = 0.83) than women in the normal group. A comparison of the normal group and the improving group revealed that pain (OR = 2.29), poor SRH (OR = 0.45), and/or lower QoL (OR = 0.73) were related to inclusion in the improving group. In the comparison between the normal and the depressed groups, older age (OR = 1.05), lower household income (OR = 0.77), chronic diseases (OR = 1.53), pain (OR = 3.81), nonattendance at social gatherings (OR = 0.56), poor SRH (OR = 0.33), and/or lower QoL (OR = 0.71) increased the likelihood of being in the depressed group (Table 3.4). Furthermore, compared to the improving and depressed groups, physical health without chronic disease (OR = 0.57), disability (OR = 0.32), and/or attendance at social gatherings (OR = 1.73) were related to improvements in symptoms (Table 3.5).

Table 3.2. Weighted proportions and mean of explanatory variables to the trajectories of depressive symptoms according to gender by χ^2 test and GLM

	Men					Women					
Variables at baseline	Normal (*n*=183)	Mild depressed (*n*=667)	Worsening (*n*=459)	Depressed (*n*=257)	*p-value*	Normal (*n*=196)	Mild depressed (*n*=613)	Worsening (*n*=607)	Improving (*n*=136)	Depressed (*n*=549)	*p-value*
Age, Mean*	65.2	66.1	67.5	69.6	<.0001	66.9	67.7	68.6	68.7	70.3	<.0001
Education											
Middle school or lower	55.6	57.4	58.7	79.7	<.0001	88.4	86.1	90.0	94.9	97.0	<.0001
High school or higher	44.4	42.6	41.3	20.3		11.6	13.9	10.0	5.1	3.0	
Economic activity											
Unemployed	46.0	51.4	61.1	75.5	<.0001	86.3	83.0	85.1	81.8	87.0	0.311
Employed	54.1	48.6	38.9	24.6		13.7	17.0	14.9	18.2	13.0	
Household income											
Q1	22.1	21.9	26.3	38.8	<.0001	27.6	30.8	33.7	37.1	47.0	<.0001
Q2	33.4	34.0	34.3	38.9		30.9	31.5	31.2	41.3	31.4	
Q3	19.7	23.4	22.0	16.7		19.6	19.4	21.7	13.1	13.4	
Q4	24.8	20.7	17.3	5.6		21.8	18.3	13.4	8.4	8.2	
Marital status											
Single	7.5	3.8	7.2	15.8	<.0001	34.8	33.9	39.0	47.6	50.7	<.0001
Married	92.5	96.2	92.8	84.2		65.2	66.1	61.0	52.4	49.3	
Chronic disease											
Yes	42.6	48.7	56.0	64.5	<.0001	54.8	58.8	62.9	65.7	79.4	<.0001
No	57.4	51.3	44.0	35.5		45.2	41.2	37.2	34.3	20.6	
Pain											
Yes	40.3	49.5	58.5	76.5	<.0001	71.9	80.8	88.2	92.4	96.2	<.0001
No	59.7	50.5	41.6	23.5		28.1	19.3	11.8	7.6	3.8	
Social gathering											
Yes	56.4	59.2	57.5	40.7	<.0001	55.4	48.6	44.4	47.8	33.5	<.0001
No	43.7	40.8	42.5	59.3		44.6	51.4	55.6	52.2	66.5	
Reunions											
Yes	34.0	30.2	22.4	10.9	<.0001	10.3	5.4	3.8	3.9	1.8	<.0001

Table 3.2. *(continued)*

No	66.0	69.8	77.6	89.1		89.7	94.6	96.3	96.1	98.2	
Disability											
Yes	3.9	7.8	9.0	13.6	0.003	3.0	3.1	4.6	3.7	12.3	<.0001
No	96.1	92.2	91.1	86.4		97.0	96.9	95.4	96.4	87.7	
SRH											
Poor	9.4	20.7	29.6	60.3	<.0001	29.1	30.7	40.8	63.1	79.5	<.0001
Fair	34.8	34.6	32.9	29.1		34.2	39.5	39.0	31.1	17.2	
Good	55.9	44.6	37.5	10.6		36.7	29.9	20.2	5.9	3.3	
QoL, Mean*	6.4	5.7	5.2	3.3	<.0001	6.4	5.8	4.8	3.7	3.2	<.0001

SRH: Self-rated Health, QoL: Quality of Life

*Weighted mean was analyzed by GLM,

Table 3.3. Weighted odds ratios of explanatory variables to the trajectories of depressive symptoms in the elderly men by multinomial logistic regression

	Mild depressed (*n*=667)			Worsening (*n*=459)			Depressed (*n*=257)		
Variables at baseline (Ref)	OR	(95% CI)	*p-value*	OR	(95% CI)	*p-value*	OR	(95% CI)	*p-value*
Age*	1.02	(0.99-1.06)	0.237	1.05	(1.01-1.08)	0.007	1.07	(1.03-1.11)	0.001
Education (Middle school or lower)	1.14	(0.81-1.61)	0.454	1.38	(0.95-1.99)	0.088	0.86	(0.53-1.40)	0.546
Economic activity (Unemployed)	0.92	(0.66-1.28)	0.607	0.73	(0.51-1.04)	0.085	0.53	(0.33-0.84)	0.008
Household income (Q1)	1.05	(0.89-1.23)	0.562	1.05	(0.88-1.24)	0.590	0.88	(0.70-1.10)	0.250
Marital status (Single)	2.19	(1.13-4.24)	0.020	1.20	(0.63-2.30)	0.580	0.61	(0.30-1.25)	0.177
Chronic disease (No)	1.07	(0.76-1.49)	0.703	1.30	(0.91-1.85)	0.153	1.32	(0.85-2.07)	0.220
Pain (No)	1.15	(0.82-1.62)	0.411	1.49	(1.03-2.14)	0.033	2.01	(1.26-3.22)	0.004
Social gathering (No)	1.23	(0.89-1.71)	0.208	1.28	(0.90-1.81)	0.170	0.87	(0.57-1.33)	0.511
Reunions (No)	0.90	(0.62-1.29)	0.554	0.66	(0.44-0.98)	0.040	0.57	(0.32-1.02)	0.060
SRH (Poor)	0.77	(0.60-0.98)	0.033	0.70	(0.54-0.90)	0.006	0.36	(0.26-0.50)	<.0001
Disability (No)	1.53	(0.71-3.30)	0.281	1.43	(0.64-3.16)	0.383	1.05	(0.44-2.50)	0.911
QoL*	0.91	(0.85-0.97)	0.004	0.87	(0.82-0.93)	<.0001	0.70	(0.64-0.76)	<.0001

OR: Odds ratio, CI: Confidence interval, Ref: Reference group, SRH: Self-rated Health, QoL: Quality of Life

*Age and QoL were included as continuous variable

Table 3.4. Weighted odds ratios of explanatory variables to the trajectories of depressive symptoms in the elderly women by multinomial logistic regression

	Mild depressed (*n*=613)			Worsening (*n*=607)			Improving (*n*=136)			Depressed (*n*=549)		
Variables at baseline (Ref)	OR	(95% CI)	*p-value*	OR	(95% CI)	*p-value*	OR	(95% CI)	*p-value*	OR	(95% CI)	*p-value*
Age*	1.03	(1.00-1.06)	0.097	1.04	(1.01-1.07)	0.022	1.02	(0.98-1.06)	0.366	1.05	(1.02-1.08)	0.004
Education (Middle school or lower)	1.78	(1.04-3.05)	0.037	1.65	(0.93-2.90)	0.086	1.17	(0.45-3.07)	0.746	0.94	(0.44-2.01)	0.868
Economic activity (Unemployed)	1.40	(0.87-2.25)	0.162	1.31	(0.80-2.13)	0.281	1.79	(0.95-3.40)	0.074	1.37	(0.80-2.34)	0.249
Household income (Q1)	0.94	(0.81-1.09)	0.401	0.90	(0.77-1.05)	0.196	0.80	(0.64-1.01)	0.057	0.77	(0.64-0.92)	0.003
Marital status (Single)	1.18	(0.81-1.72)	0.388	1.03	(0.71-1.51)	0.878	0.69	(0.42-1.15)	0.157	0.74	(0.49-1.11)	0.145
Chronic disease (No)	1.11	(0.78-1.57)	0.558	1.11	(0.78-1.58)	0.577	0.87	(0.53-1.44)	0.591	1.53	(1.02-2.30)	0.039
Pain (No)	1.57	(1.05-2.37)	0.030	2.29	(1.48-3.55)	0.0002	2.29	(1.06-4.94)	0.035	3.81	(2.04-7.12)	<.0001
Social gathering (No)	0.83	(0.60-1.16)	0.277	0.77	(0.55-1.08)	0.123	0.97	(0.60-1.55)	0.888	0.56	(0.38-0.81)	0.002
Reunions (No)	0.50	(0.27-0.93)	0.029	0.44	(0.23-0.87)	0.018	0.67	(0.23-1.96)	0.464	0.41	(0.17-1.01)	0.051
SRH (Poor)	1.04	(0.81-1.33)	0.757	0.89	(0.70-1.14)	0.362	0.45	(0.31-0.66)	<.0001	0.33	(0.24-0.44)	<.0001
Disability (No)	0.99	(0.37-2.60)	0.976	1.20	(0.46-3.10)	0.708	0.70	(0.20-2.49)	0.578	2.17	(0.85-5.52)	0.105
QoL*	0.92	(0.87-0.99)	0.019	0.83	(0.78-0.89)	<.0001	0.73	(0.66-0.80)	<.0001	0.71	(0.66-0.76)	<.0001

OR: Odds ratio, CI: Confidence interval, Ref: Reference group, SRH: Self-rated Health, QoL: Quality of Life

*Age and QoL were included as continuous variable

Table 3.5. Weighted odds ratios of explanatory variables to the trajectories of depressive symptoms in the elderly women by multinomial logistic regression (Reference group: Depressed)

	Improved (n=136)		
Variables at baseline (Ref)	OR	(95% CI)	*p-value*
Age*	0.97	(0.94-1.01)	0.10
Education (Middle school or lower)	1.25	(0.47-3.30)	0.65
Economic activity (Unemployed)	1.31	(0.77-2.22)	0.32
Household income (Q1)	1.04	(0.85-1.28)	0.70
Marital status (Single)	0.94	(0.61-1.43)	0.76
Chronic disease (No)	0.57	(0.37-0.88)	0.01
Pain (No)	0.60	(0.27-1.36)	0.22
Social gathering (No)	1.73	(1.16-2.59)	0.01
Reunions (No)	1.62	(0.52-5.04)	0.40
SRH (Poor)	1.38	(0.96-1.97)	0.08
Disability (No)	0.32	(0.12-0.84)	0.02
QoL*	1.03	(0.95-1.13)	0.46

OR: Odds ratio, CI: Confidence interval, Ref: Reference group, SRH: Self-rated Health, QoL: Quality of Life

*Age and QoL were included as continuous variable

Discussion

The primary purposes of the present study were to investigate various changes in the trajectories of depressive symptoms over time and to determine the factors related to these changes. A GBTM was employed to achieve these purposes and the different trajectories were assessed according to gender. In the case of the elderly men, four types of trajectories were identified and were relatively constant or gradually increased. In contrast, five types of trajectories were identified in women with an additional improved group. After confirming the trajectories of depressive symptoms, the relevant factors that influenced membership in each trajectory were determined. For men, the common risk factors of having depressive symptoms were poor SRH, lower QoL, and pain. Additionally, economic activity had a preventive effect when compared to the normal and depressed groups. In the case of elderly women, physical pain and lower QoL were the common risk factors related to depressive symptoms while chronic diseases, poor SRH, and a lower economic status were associated with depressive symptoms for some groups. Moreover, social participation, such as attending social gatherings or reunions, had a preventive effect against depressive symptoms in women.

Previous studies have shown that physical health status is associated with mental health problems such as depressive symptoms, and that chronic diseases and functional limitations increase the risk of depressive symptoms (Berkman et al., 1986; G. J. Kennedy, Kelman, & Thomas, 1990). Although the specific variables related to physical health status identified in the present study were not identical to those observed in preceding studies, the present results corresponded well with those of

previous studies (Berkman et al., 1986; G. J. Kennedy et al., 1990). SRH status (perceived health status) has been associated with depressive symptoms such that a poor SRH aggravates depressive symptoms and, in this respect, the present findings were consistent with those of previous studies (Beekman et al., 1995; Minicuci, Maggi, Pavan, Enzi, & Crepaldi, 2002). In the present study, individuals with pain were more likely to be depressed as observed in earlier studies which indicated that pain was a prominent risk factor of depressive symptoms (Arola, Nicholls, Mallen, & Thomas, 2010; Novick et al., 2015). Based on these findings, it is possible that the management of chronic somatic diseases is an important factor in the prevention of depressive symptoms. This is important because later life is a period associated with the multi-morbidity of chronic somatic diseases and prevention is more cost-effective than treatment regarding chronic diseases.

In the present study, QoL was assessed as a variable of life satisfaction and was significantly associated with depressive symptoms in almost every group, which is consistent with the findings of a previous study (Goldney, Fisher, Wilson, & Cheok, 2000). Even though the present results suggested a causal relationship between QoL at baseline and subsequent worsening of depressive symptoms, depression was also a risk factor for lower QoL, and depressed patients tended to underestimate their own QoL (Pyne, Patterson, Kaplan, & Ho, 1997). Therefore, it is important to break the vicious cycle that exists between lower QoL and depressive symptoms. This will likely require comprehensive care because QoL encompasses the physical, mental, and socioeconomic statuses of individuals.

Gender differences were identified in the shapes of the trajectories of

depressive symptoms and in the associations between depressive symptoms and related factors in the present study. The group improved in depressive symptoms was included only in the elderly women. The variables that were protective against depressive symptoms differed according to gender in the normal and depressed groups, more specifically, employment for men and social participation for women. The finding that employment in men was protective against depressive symptoms agrees with a previous study (Blay, Andreoli, Fillenbaum, & Gastal, 2007), but contrasts with the findings of several previous studies that did not find any relationship between employment and depressive symptoms (Barcelos-Ferreira et al., 2009; Lorant et al., 2007). Only a few studies have investigated the relationship between employment and depressive symptoms among the elderly. It may be inappropriate to use employment as a socioeconomic variable when investigating elderly populations because it is more likely that these individuals are retired as they have reached a later stage of life. Nonetheless, it is important to focus on the effects of employment in South Korea. The employment rate among the elderly in South Korea has reached 30% (Statistics Korea, 2016) and the number of older workers will likely further increase in the near future due to the rapid aging of the population. However, employment itself, while increasing household income, may be a factor related to decreases in physical health because most jobs available to elderly individuals require manual labor. Therefore, employment policies that reflect the characteristics of the elderly in terms of health promotion, including the improvement of depressive symptoms, are needed because employment can mitigate the adverse effects of a lower socioeconomic status in terms of health.

The present study also showed that social participation, such as

participating in social gatherings and reunions, had a beneficial effect on depressive symptoms in women. In the comparison of the improving and depressed groups in which the CES-D 10 scores were high at baseline, similar results were observed; these findings are in close agreement with those of a previous study (Chiao, Weng, & Botticello, 2011). It is presumed that a lower employment rate means fewer opportunities to meet someone new and, therefore, social gatherings or reunions may be the only way that elderly women can interact with others. Regardless of gender, several longitudinal studies had demonstrated the beneficial effects of social participation on depression according to a systematic review (Schwarzbach, Luppa, Forstmeier, König, & Riedel-Heller, 2014). For example, a greater degree of social participation is more likely to result in social support and/or more access to social ties, which can improve depressive symptoms. Therefore, there may be a need for more facilities at which elderly individuals can meet and communicate with others.

The present study differed from previous studies in terms of study design and analytical methods. Most prospective studies investigating the risk factors of depression in the elderly have been conducted in Western developed countries such as the US, UK, and Netherlands (Cole & Dendukuri, 2003). The present study observed a causal relationship between depressive symptoms and their risk factors using longitudinal data relevant to the social and cultural contexts of South Korea. The study subjects were typically divided into normal and depressed groups using a cut-off value of the CES-D score in recent studies (Olvera, Fisher-Hoch, Williamson, Vatcheva, & McCormick, 2016; Richard et al., 2013). However, understanding the changing patterns of individual depressive symptoms in greater detail can provide important information beyond classifying individuals into two groups, normal or

depressed.

The present findings have several policy implications; the different trajectories related to depressive symptoms may require different interventions to improve the symptoms. First, there was a distinct group among women that initially had a high CES-D score but exhibited a gradual improvement in symptoms. This group was characterized by greater degrees of physical health and social participation relative to the depressed group, which had a similar starting score. Therefore, it will be important to provide a place for the elderly to communicate with one another and the health promotion policy to reduce depressive symptoms. Second, the elderly population can be divided into normal and depressed groups at any given time. Each group, however, may consist of a mixture of various trajectory groups. Because each group is heterogeneous, personalized interventions that reflect individual characteristics may be more effective. Finally, economic stability is important to mitigate depressive symptoms but different approaches are needed according to gender. These policy implications constitute the greatest advantage of using this trajectory analysis.

Despite the significance of the present study, there are several limitations that should be considered. First, the follow-up period was slightly shorter than those of studies conducted in Western countries because the KLoSA panel surveys only began recently. However, meaningful results were found in the existing data and the findings are expected to become more relevant as more data are accumulated. Second, participants who died or failed to complete the survey were excluded from the present analyses and these individuals may have been more depressed than the living participants. Furthermore, a certain trajectory group might have been formed on the

basis of the specific profile of the deceased participants and the exclusion of this participants may have caused this group to disappear. However, this possibility is considered to be unlikely and it is more feasible that the deceased participants were distributed to each group. In this case, the percentage of each trajectory group may change due to the exclusion of the deceased participants but it is expected that there will not be a significant impact on the overall patterns. Additionally, the purposes of the present study include determining the degree of health care burden caused by depressive symptoms and providing policy suggestions to improve this burden by identifying the trajectories and risk factors of depressive symptoms. For these reasons, living participants are a target population that more closely match this purpose of the present study. Third, although the Geriatric Depression Scale (GDS) is more frequently used for elderly populations, the CES-D 10 was used to measure depressive symptoms among the elderly in the present study. The use of this measure is supported by previous findings showing that the CES-D can be applied to the elderly because it is not influenced by age (Radloff & Teri, 1986). Even though only elderly participants aged 60 years or older were included in the present study, the KLoSA assessed adults over 45 years of age. Therefore, it was preferable to use a general method like the CES-D 10.

In conclusion, the present study demonstrated that there are gender differences in the trajectory of depressive symptoms and its associated risk factors. More specifically, the maintenance of a healthy body was important to reduce the risk of depressive symptoms in both genders, employment was a critical factor to improve depressive symptoms in older men, and social participation was protective against depressive symptoms in older women. The findings of the present study also

indicated that job creation reflecting the physical and mental conditions of the elderly is needed and that policies to promote social participation of the elderly is important. Therefore, the elderly should be provided with comprehensive services that protect their mental health.

CHAPTER IV.

Pain Trajectories and the Associated Risk Factors among the elderly

Introduction

Pain is one of the symptoms most commonly found in the elderly. In South Korea, approximately 80% of people aged 60 and older are reported to experience pain at a given time (Ministry of Health & Welfare, 2008), occurring rather frequently in South Korea compared to other countries ranges from 19.2 to 52.9% (Henderson, Harrison, Britt, Bayram, & Miller, 2013; Jackson, Chen, Iezzi, Yee, & Chen, 2014; Patel, Guralnik, Dansie, & Turk, 2013). Physical pain causes patients discomfort which leads to interfere with their independent daily living and leads to limitations in economic activities (Breivik, Collett, Ventafridda, Cohen, & Gallacher, 2006), also has worsening effects on depression (Arola, Nicholls, Mallen, & Thomas, 2010) and quality of life (QoL) (Niv & Kreitler, 2001), and may lead to suicide in extreme cases (Ratcliffe, Enns, Belik, & Sareen, 2008). Pain is a common symptom of the elderly and pain of the elderly aggravates physical and mental functioning; therefore, the increase of older population will lead to a corresponding increase demand for pain management (Gagliese, 2009).

Despite the high prevalence and accompanying risks of pain in the elderly, studies of the elderly in pain are often ignored. A review on the causes of this academic negligence concluded with two socially prevalent but erroneous stereotypes regarding pain in the elderly; pain is part of the natural process of aging; elderly people are more likely to complain about discomfort and pain than younger people, despite less sensitive to pain (Gagliese, 2009). Perhaps because of these prejudices, elderly people themselves tend to deny their pain symptoms. According to a review, the elderly are often reluctant to report pain either because of the

erroneous beliefs around them which take pain in the elderly for granted, or because of fear of negative consequences arisen from the recognition of their pain (Herr & Mobily, 1991). Difficulties to report and diagnose pain among the elderly result from these problems, which can further become problematic to study.

Screening for pain among the elderly is the first step of intervention, as the appropriate treatment can only be provided after a correct assessment. However, accurate pain assessment is difficult despite the number of existing measurement systems such as the visual analogue scale (VAS), McGill pain questionnaire, and numerical rating scale (NRS). This is because pain is a personal and subjective symptom, and this features of pain cause medical staff to be dependent ultimately on the response of the patients (Choinière, Melzack, Girard, Rondeau, & Paquin, 1990; Encandela, 1993). Additionally, age-related mild cognitive impairment may cause elderly patients to have difficulty expressing symptoms of pain; as a result, the diagnosis of pain becomes an even more formidable task (Herr & Mobily, 1991). Thus, it is difficult to determine the exact prevalence and characteristics of pain in a population. A cross-sectional study designed to investigate status at any one point in time may be insufficient because of the limitation in measurement of pain. Moreover, the health status of an elderly patient is a result of a prolonged lifetime, which cannot be reflected by a cross-sectional design. A panel study can address the difficulty in assessment of pain because the repeated measures increase the reliability of the assessment.

Longitudinal studies can be utilized to identify a causal relationship empirically because they are designed to show changes in variables over time.

However, obstacles still remain in relation to creating proper criteria for classifying meaningful subgroups in the context of changing patterns. Group-based trajectory modeling (GBTM) that tracks patterns over time can be an effective solution to this problem. With regard to interesting variables, individuals who exhibit similar patterns of change are grouped into subgroups by trajectory analysis (Nagin, 2005). The term, pain trajectories, is used for these patterns of pain over time in this study. The strength of this model is that it could more accurately reflect the changing status of actual pain of the elderly than other conventional methods, by utilizing information from the repeated measures.

Differences in the experience of pain by gender are well documented. In a systematic review, many researchers reported that women are vulnerable to experience pain and multi-site pain, compared to men (Andersson, Ejlertsson, Leden, & Rosenberg, 1993; Blyth et al., 2001). In a comparison between developing and developed countries, the prevalence of pain was higher among women regardless of the level of national development (Tsang et al., 2008). Furthermore, conforming to different social norms and gender roles differentiates life experiences between men and women, which suggests that psychological, sociological, and biological factors should also be considered (Unruh, 1996). For these reasons, identifying the factors related to pain with regard to gender is important. Thus, this study was conducted to investigate pain trajectories among the elderly and the risk factors that affect them, according to gender.

Subjects and Methods

1. Data

The data used in this study were drawn from the baseline (2006) through fifth-wave (2014) surveys of the Korean Longitudinal Study of Ageing (KLoSA), which was conducted among the adults over 45 years of age residing in households in South Korea. The survey has been conducted every two years after the baseline survey in 2006. The study population of the KLoSA was selected by means of stratified multi-stage sampling with the purpose of guaranteeing national representativeness. A total of 10,254 people investigated using Computer-Assisted Personal Interviewing (CAPI) were participated in the baseline survey (2006) (Lee, Jang, & Cho, 2017).

For the purposes of this study, the participants who did not finish all of the surveys through the fifth wave due to death (n = 1,261) or failure to follow-up (n = 1,964) were excluded, as were those with incomplete information from at least one of the surveys (n = 438). Participation was restricted to individuals aged 60 years and older; thus, subjects who were younger than 60 years of age (n = 3,214) were also excluded. Subjects who had a history of cancer were excluded (n = 397) in order to distinguish pain associated with aging from cancer pain. Subjects who did not provide information for all of the main explanatory variables (n = 138) were also excluded. Finally, lifelong-unemployed men were excluded from the analysis because they numbered only 22 individuals (1.7% of men) considered too few for a separate category. Ultimately, 2,820 individuals (1,171 men and 1,649 women) were included

in the analyses. This study was approved by the Institutional Review Board of Seoul National University (IRB No. E1608/003-007).

2. Variables

2.1. Pain

In every survey, pain was assessed through a question whether the subjects had pain in various parts of the body, including the head, shoulders, chest, abdomen, waist, arms, wrists, fingers, hips, legs, knees, ankles, and/or toes. The responses for each part of the body were recorded as "Yes" (1) or "No" (0), and the sum total of "Yes" responses is used as the dependent variable.

2.2. Explanatory variables at baseline

The explanatory variables such as age, education level, household income, marital status, the longest job, physical activity, experience of injuries, chronic diseases, depressive symptoms, and self-rated health (SRH) were assessed to identify risk factors that affected pain trajectories. The subjects were divided into three groups by age: aged 60–69 years, aged 70–79 years, and aged ≥ 80 years. Level of education was recorded as the highest level of education completed by the subjects and grouped into two categories: elementary school or lower and middle school or higher. Annual household income in the last year was evaluated as an open-ended

question. Equivalent household income was calculated and then divided into quartiles. Marital status was classified into two groups: married or single. Employment, according to the longest job, was classified as non-manual work or manual work for men and as non-manual work, manual work, or unemployed for women.

Physical activity level was measured by regular exercise performed at least once a week. The subjects were asked the experience of traffic accidents or falls, and were classified as having experienced injury. Chronic disease was evaluated as having a diagnosis of major chronic diseases such as cancer, cardiac disease, cerebrovascular disease, hypertension, diabetes, liver disease, chronic pulmonary disease, and/or arthritis (degenerative or rheumatoid); the subjects who had one or more chronic diseases were classified as chronic disease patients. Depressive symptoms were measured with the CES-D 10 (score range: 0–10) and the cut-off value used was 4; subjects with scores > 4 were categorized as depressed. SRH was assessed with a five-point scale (very bad, bad, fair, good, and very good); responses of "very bad" or "bad" were categorized as poor (1), responses of "fair" were categorized as fair (2), and responses of "good" or "very good" were categorized as good (3).

3. Statistical analysis

To identify the descriptive characteristics of the study population, non-weighted frequencies of explanatory variables according to gender were calculated.

Almost all explanatory variables showed significant differences in distribution according to gender; thus, analyses were performed according to gender.

Within each gender, the pain trajectory groups were identified using GBTM, which was developed to group subjects that represent similar trajectories related with interesting variables (D. S. Nagin, 2005). This model can only be used when individuals were repeatedly measured at various points in time; subsequently, the most appropriate group of trajectories was suggested by computing the probability that an individual will belong to a particular group (D. S. Nagin, 2005). There are three GBTM sub-models: censored normal (CNORM), zero inflated Poisson (ZIP), and Bernoulli (LOGIT) models. The selection of sub-model is determined by the distribution of the outcome variable; the ZIP model was selected for this study because of the skewed distribution of the outcome variable (B. L. Jones et al., 2001).

The PROC TRAJ procedure, which is part of a SAS add-in module, was used to analyze pain trajectories of the subjects. The Bayesian information criterion (BIC) value was calculated by the procedure and then used to decide the appropriate number of sub-groups with the principle of parsimony (D. S. Nagin, 2005). Men were divided into four groups and women into three. Using trajectory analysis, each individual was allocated to the trajectory group with which they had the greatest similarity. After the trajectory analysis, multinomial analyses were performed for both genders to determine the associations among pain trajectories and explanatory variables at baseline. All analyses were conducted using SAS statistical software, version 9.4 (SAS Institute, Inc., Cary, NC).

Results

Table 4.1 the general characteristics of the study population according to gender. The majority of the study population was aged 60–69 years in both genders. Women on average had a lower level of education than men. Most subjects had previously been employed, and the longest job was most commonly manual work. More than 90% of men were married, while 40% of women were single. Men appeared to be more physically active than women: 44% of men were doing regular exercise, whereas 70% of women were not physically active. The majority of subjects had one or more chronic diseases, and women were more likely than men to be categorized as depressed. Experience of injury was slightly higher than 10% in both genders, and women were more likely than men to have poor SRH.

Table 4.1. General characteristics of study populations (N=2,820)

	Men (*n*=1,171)		Women (*n*=1,649)	
Variables at baseline	*n* (%)		*n* (%)	
Age				
60-69	766	(65.41)	965	(58.34)
70-79	363	(31.00)	574	(34.70)
80≤	42	(3.59)	115	(6.95)
Education				
Less than elementary school	532	(45.43)	1355	(81.92)
Higher than middle school	639	(54.57)	299	(18.08)
Longest job				
Unemployed	-	-	180	(10.88)
Manual	862	(73.61)	1383	(83.62)
Non-manual	309	(26.39)	91	(5.50)
Household income				
Q1	258	(22.03)	420	(25.39)
Q2	291	(24.85)	435	(26.30)
Q3	308	(26.30)	406	(24.55)
Q4	314	(26.81)	393	(23.76)
Marital status				
Single	77	(6.58)	672	(40.63)
Married	1094	(93.42)	982	(59.37)
Physical activity				
Active	511	(43.64)	480	(29.02)
Inactive	660	(56.36)	1174	(70.98)
Chronic disease				
Yes	586	(50.04)	1066	(64.45)
No	585	(49.96)	588	(35.55)
Depressive symptoms				
Yes	310	(26.47)	714	(43.17)
No	861	(73.53)	940	(56.83)
Injury				
Yes	147	(12.55)	248	(14.99)
No	1024	(87.45)	1406	(85.01)
SRH				
Poor	294	(25.11)	780	(47.16)
Fair	446	(38.09)	550	(33.25)
Good	431	(36.81)	324	(19.59)
Outpatient				
Yes	650	(55.51)	1042	(63.19)
No	521	(44.49)	607	(36.81)

This study corroborated that experience of pain differs by gender, as shown in Figures 1 and 2 (The numbers on the x-axis refer to the survey waves: 1 = 2006, 2 = 2008, 3 = 2010, 4 = 2012, and 5 = 2014.) Men were divided into four pain trajectory groups: normal (Group 1), single site (Group 2), improved single site (Group 3), and multi-site (Group 4) (see Figure 1). Women were divided into three groups of pain trajectory over time: single site (Group 1), double site (Group 2), and multi-site (Group 3) (see Figure 4.2).

Table 4.2 shows differences in the distributions of explanatory variables according to pain trajectory group; almost every variable was found to have statistically significant differences. For both genders, as the number of sites with pain increased, the subjects were more likely to be older, have less education, have engaged in manual work, and have a lower household income. The relatively pain-free groups (normal group in men and single site group in women) were more likely to be physically active, have no chronic disease, have good SRH, do not receive outpatient service, and be less likely to be depressed.

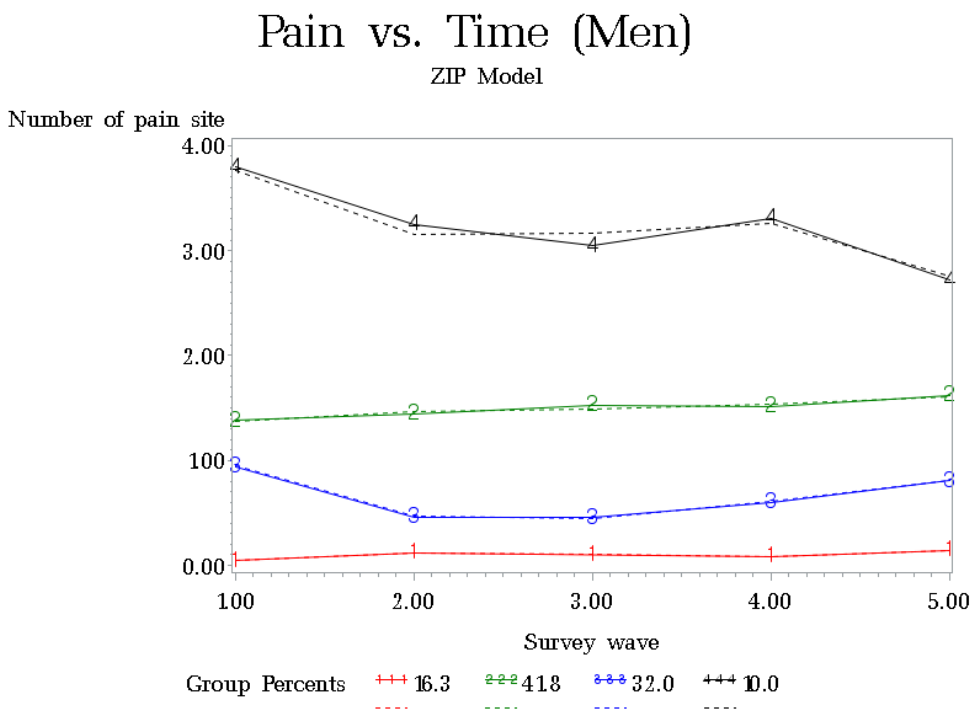

Figure 4.1. Trajplot indicates the changes of number of sites with pain as index of integrated pain in elderly men. The scaled time represents the survey wave (1 = 2006, 2 = 2008, 3 = 2010, 4 = 2012, 5 = 2014).

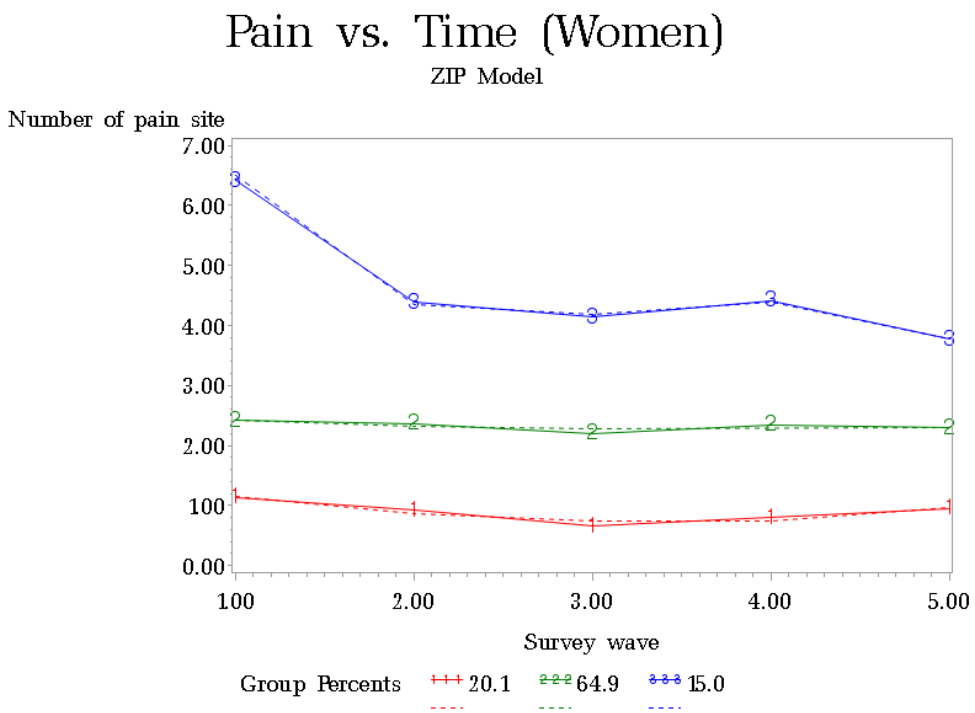

Figure 4.2. Trajplot indicates the changes of number of sites with pain as index of integrated pain in elderly women. The scaled time represents the survey wave (1 = 2006, 2 = 2008, 3 = 2010, 4 = 2012, 5 = 2014).

Table 4.2. Weighted proportions of explanatory variables to pain trajectories according to gender by χ^2 test

	Men (*n*=1,171)					Women (*n*=1,649)			
Variables at baseline	Normal (*n*=216)	Single site (*n*=498)	I_single site (*n*=354)	Multi-site (*n*=103)	*p-value*	Single site (*n*=316)	Double site (*n*=1,104)	Multi-site (*n*=229)	*p-value*
Age, %									
60-69	76.85	58.03	72.6	52.43	<.0001	68.24	57.04	50.88	0.0005
70-79	21.3	37.55	24.58	41.75		25.47	36.28	39.91	
80-	1.85	4.42	2.82	5.83		6.29	6.68	9.21	
Education, %									
Less than elementary school	24.07	57.43	37.85	58.25	<.0001	67.92	85.02	86.4	<.0001
Higher than middle school	75.93	42.57	62.15	41.75		32.08	14.98	13.6	
Longest job, %									
Manual	55.09	82.53	69.49	83.5	<.0001	72.01	86.1	87.72	<.0001
Non-manual	44.91	17.47	30.51	16.5		12.58	3.79	3.95	
Unemployed	-	-	-	-		15.41	10.11	8.33	
Household income, %									
Q1	18.06	22.49	22.32	27.18	<.0001	20.75	24.1	38.16	<.0001
Q2	14.81	29.12	21.47	36.89		21.7	27.62	26.32	
Q3	23.61	28.11	28.25	16.5		24.84	25.72	18.42	
Q4	43.52	20.28	27.97	19.42		32.7	22.56	17.11	
Marital status, %									
Single	8.33	7.83	4.24	4.85	0.111	38.05	40.61	44.3	0.341
Married	91.67	92.17	95.76	95.15		61.95	59.39	55.7	
PA, %									
Active	60.65	34.14	51.41	27.18	<.0001	43.4	26.44	21.49	<.0001
Inactive	39.35	65.86	48.59	72.82		56.6	73.56	78.51	
Chronic disease, %									
Yes	40.28	53.21	47.18	65.05	0.0001	44.34	67.69	76.75	<.0001
No	59.72	46.79	52.82	34.95		55.66	32.31	23.25	
Depressive symptoms, %									
Yes	12.04	36.14	17.8	39.81	<.0001	27.36	43.68	62.72	<.0001

Table 4.2. *(continued)*

No	87.96	63.86	82.2	60.19		72.64	56.32	37.28	
Injury, %									
Yes	7.87	13.65	12.71	16.5	0.096	12.26	13.99	23.68	0.0003
No	92.13	86.35	87.29	83.5		87.74	86.01	76.32	
SRH, %									
Poor	6.48	32.33	18.64	51.46	<.0001	22.01	48.1	77.63	<.0001
Fair	31.48	41.97	37.29	35.92		35.85	35.65	17.98	
Good	62.04	25.7	44.07	12.62		42.14	16.25	4.39	
Outpatient									
Yes	45.83	62.25	50.28	61.17	<.0001	56.33	63.41	71.62	0.001
No	54.17	37.75	49.72	38.83		43.67	36.59	28.38	

PA: Physical activity, SRH: Self-rated health, I_Single site: Improved single site

Tables 4.3 and 4.4 show correlations between explanatory variables and pain trajectory groups for both genders. For men (Table 4.3), the risk of belonging to the single site group increased with age, and with lower education. Men whose longest job held involved manual work were more likely to be in the pain groups than in the normal group. Married men were more likely to belong to the pain groups. Lack of physical activity, depressive symptoms, experience of injury, poor SRH, and experience of outpatient service increased the risk of pain in the single site group. Elderly men with experience of injury, or poor SRH were more likely to be in the improving single site group than in the normal group. Men in the multi-site group were more likely to be physically inactive, have chronic disease, be depressed, have experienced injury, have poor SRH, and have received outpatient service.

Table 4.4 shows the results for women subjects. As age increased, so did the risk of belonging to the multi-site group. Manual workers were more likely to be in double site group than were non-manual workers. Women who were not physically active, had chronic diseases, had poor SRH, and received outpatient service were more likely to be in the double site group than in the single site group. Women in the multi-site group were more likely to have lower household income, not be physically active, have chronic diseases, be depressed, have poor SRH, and have received outpatient service.

Table 4.3. Weighted odds ratios of explanatory variables to pain trajectories in the elderly men by multinomial logistic regression (Reference trajectory: Normal)

	Single site (*n*=498)			I_single site (*n*=354)			Multi-site (*n*=103)		
Variables at baseline (REF)	OR	(95% CI)	*p-value*	OR	(95% CI)	*p-value*	OR	(95% CI)	*p-value*
Age (60s)	1.57	(1.06-2.32)	0.025	1.04	(0.70-1.56)	0.842	1.61	(0.95-2.72)	0.078
Education (Elementary school or lower)	0.49	(0.33-0.75)	0.001	0.77	(0.51-1.17)	0.227	0.68	(0.37-1.25)	0.209
The longest job (Manual vs. Non-manual)	2.30	(1.52-3.48)	<.0001	1.50	(1.03-2.19)	0.034	3.07	(1.46-6.47)	0.003
Household income (Q1)	0.87	(0.74-1.02)	0.090	0.87	(0.74-1.02)	0.080	0.83	(0.64-1.07)	0.147
Marital status (Single)	2.05	(1.10-3.82)	0.025	3.51	(1.74-7.10)	0.001	5.06	(1.56-16.39)	0.007
PA (Inactive)	0.59	(0.41-0.86)	0.006	0.93	(0.65-1.34)	0.712	0.38	(0.21-0.69)	0.002
Chronic disease (No)	1.30	(0.90-1.89)	0.168	1.08	(0.75-1.55)	0.689	1.88	(1.06-3.35)	0.032
Depressive symptoms (No)	2.06	(1.28-3.32)	0.003	1.17	(0.71-1.93)	0.537	2.46	(1.30-4.63)	0.006
Injury (No)	2.46	(1.33-4.56)	0.004	1.95	(1.05-3.62)	0.034	2.36	(1.03-5.39)	0.042
SRH (Poor)	0.46	(0.35-0.60)	<.0001	0.56	(0.43-0.73)	<.0001	0.26	(0.17-0.40)	<.0001
Outpatient (No)	1.73	(1.21-2.48)	0.003	0.97	(0.69-1.37)	0.871	1.80	(1.04-3.13)	0.037

OR: Odds ratio, CI: Confidence interval, REF: Reference group, PA: Physical activity, SRH: Self-rated health, I_single site: Improved single site

Table 4.4. Weighted odds ratios of explanatory variables to pain trajectories in the elderly women by multinomial logistic regression (Reference trajectory: Single site)

	Double site (*n*=1,104)			Multi-site (*n*=229)		
Variables at baseline (REF)	OR	(95% CI)	*p-value*	OR	(95% CI)	*p-value*
Age (60s)	1.18	(0.93-1.50)	0.185	1.56	(1.13-2.16)	0.008
Education (Elementary school or lower)	0.77	(0.55-1.10)	0.148	0.98	(0.56-1.71)	0.940
The longest job (Unemployed vs. Non-manual)	0.96	(0.53-1.74)	0.887	0.64	(0.22-1.82)	0.398
The longest job (Manual vs. Non-manual)	1.77	(1.05-2.99)	0.034	1.50	(0.60-3.78)	0.386
Household income (Q1)	0.96	(0.85-1.09)	0.539	0.78	(0.66-0.93)	0.006
Marital status (Single)	1.11	(0.83-1.48)	0.501	1.26	(0.84-1.89)	0.269
PA (Inactive)	0.58	(0.43-0.77)	0.000	0.49	(0.32-0.76)	0.001
Chronic disease (No)	2.00	(1.51-2.63)	<.0001	1.98	(1.30-3.01)	0.001
Depressive symptoms (No)	1.31	(0.96-1.78)	0.085	1.93	(1.28-2.92)	0.002
Injury (No)	0.94	(0.63-1.40)	0.748	1.59	(0.97-2.62)	0.066
SRH (Poor)	0.53	(0.44-0.64)	<.0001	0.24	(0.18-0.33)	<.0001
Outpatient (No)	1.16	(0.88-1.53)	0.283	1.60	(1.07-2.38)	0.021

OR: Odds ratio, CI: Confidence interval, REF: Reference group, PA: Physical activity, SRH: Self-rated health

Discussion

The purpose of this study was to investigate pain trajectories and identify risk factors affecting such trajectories; GBTM was used to achieve this goal. Four distinct pain trajectories were identified in men, and three in women. After classifying pain trajectories, potential risk factors were investigated by comparing the group with the least pain to the other groups. The common risk factors of pain were lack of physical activity, chronic disease, and depressive symptoms regardless of gender. The longest job demanding manual work, experience of injury, and married status, were associated with multi-site pain in older men, but these associations were not found in older women. Among women, lower household income was related to pain in multi-site pain group.

Changing pattern of pain seemed to be persistent in this study; it can be regarded that the proper treatment did not provided to those people. Although pain has a good prognosis if early treatment is offered, the treatment rate for pain is not high compared to the prevalence of pain. This phenomenon can be explained by the fact that pain of old age tends to be regarded as simple symptoms or a process of aging, and these misperceptions cause the elderly to refrain from mentioning their pain (Herr & Mobily, 1991). This in turn leads to a delay in treatment, which increases both the prevalence and the severity of pain. Therefore, there is a need to change public perception of pain related to the elderly. In fact, pain is one of the conditions most in need of intervention because pain accounts for a significant proportion of the medical expenses of the elderly, and the demand for pain management will be dramatically increased as we become a super-aged society.

This study demonstrated that subjective health status indicators such as SRH and depressive symptoms are associated with pain. Previous studies have shown that study subjects with poor SRH were more likely to be in the pain groups or have worse pain (Gureje, Simon, & Von Korff, 2001; Rosso, Gallagher, Luborsky, & Mossey, 2008). Despite differences in the indicators for measuring pain, the results of this study were consistent with those of previous studies. Pain was found to be exacerbated by depressive symptoms in this study. These findings correspond well with those found in an earlier prospective cohort study, showing that a high score of depression at baseline led to a higher risk of pain (Arola et al., 2010). Although this study demonstrated pain is associated with depressive symptoms, pain is also found as one of the risk factors for poor SRH and depression (Arola et al., 2010; Mäntyselkä, Turunen, Ahonen, & Kumpusalo, 2003; Reyes-Gibby, Aday, & Cleeland, 2002). Thus, policies that can cut the connections between each factor are needed because subjective health status and pain are closely connected.

The inextricable relationship between pain and negative physical health status, such as chronic diseases and experience of injury, was demonstrated in this study. In the perspective of chronic disease, previous studies have found that the risk of pain was increased in elderly subjects diagnosed with chronic diseases (Reyes-Gibby, Aday, Todd, Cleeland, & Anderson, 2007; Shi, Hooten, Roberts, & Warner, 2010); the results of this study were in close agreement with those found in the previous studies. Injuries from traffic accidents or falls also appear to increase the risk of pain in this study; these findings correspond with earlier prospective studies (G. T. Jones et al., 2011; G. T. Jones, Power, & Macfarlane, 2009). Intervention efforts to prevent chronic diseases and injuries can therefore reduce the risk of pain,

as well as save the resources that would otherwise be spent on treatment and rehabilitation.

In this study, physical activity was significantly associated with pain in all groups regardless of gender. Although the effect of physical activity is somewhat controversial due to no benefit some studies have found (Kamada et al., 2014; Mailloux, Finno, & Rainville, 2006), the preventive effect of physical activity on pain is generally accepted (Kelley, Kelley, Hootman, & Jones, 2011; Rainville et al., 2004). Previous prospective studies found that physical activity had a preventive effect on pain (Pinto et al., 2014), and that people who were physically active had a reduced risk of pain (Nilsen, Holtermann, & Mork, 2011). These previous findings are consistent with the results of this study. Despite the benefits of physical activity, interventional approaches focused on increasing physical activity should be carefully adapted to physical function of the elderly in order to avoid injury. In addition, sustained participation is critical to receiving the benefits of physical activity; this can be improved through various community efforts and utilization of mHealth (mobile health) to motivate the elderly.

This study also found an association between pain and the class of the longest job. Risk of pain was reduced by non-manual work in both genders; these results are in consistent with previous studies (Bergman et al., 2001; Mäkela et al., 1991). Although a direct comparison between the results of this study and those of previous studies is difficult due to non-identical specific variables related to employment, manual work was agreed to increase the risk of pain. Unfortunately, most employment available to the elderly is manual work in South Korea (Ministry

of Health & Welfare, 2014a). This could have major adverse physical effects since the majority of the elderly suffered from chronic diseases and pain. Thus, policies for providing jobs reflecting an individual's health status could be helpful.

In this study, married men were found to be more likely to have pain; women appeared not to be affected by marital status. This finding agrees with previous studies; the prevalence of lower back pain was higher among adults with a spouse or partner (Schoenborn, 2004; Strine & Hootman, 2007), and unmarried people were less likely to be in the pain group than were married people (Johannes, Le, Zhou, Johnston, & Dworkin, 2010). The reason for this association is not clear but it can be inferred as follows. In past patrilineal society, women were mainly responsible for housework, and men earned living expenses through employment. The tremendous responsibility for family support as a head of household had led men to work, and this environment might lead painful later life among elderly men. Moreover, the obligation to support to the family extended to later life may lead to continued occupational exposure and the high possibility of injuries induced from manual work allowed to older men; it may inevitably increase pain. Therefore, a national policy is needed to relieve the social burden and the responsibility of older men.

This study differed from previous studies in several ways. The multi-site groups showed a decrease in the number of pain sites over time in both genders in this study; however, previous studies found that the prevalence of pain tends to be increased with age (Leadley, Armstrong, Lee, Allen, & Kleijnen, 2012; Shi et al., 2010). These different effects of time on pain can be explained by the changing

patterns of each pain site. The decrease of pain in the shoulders and arms was prominent when the pain sites were analyzed in detail (data not shown). Especially in the case of shoulder pain, age, adverse working conditions, and psychosocial factors seemed to play a major role (Cassou, Derriennic, Monfort, Norton, & Touranchet, 2002), and the pain could be improved through exercise, physiotherapy, or corticosteroid injection (Green, Buchbinder, & Hetrick, 2003). Later life is a period of increased use of healthcare services, while reducing occupational exposures due to retirement; consequently, it is possible for pain to decrease over time. Another difference was that multi-site groups had higher frequencies of outpatient treatment in both genders. The use of healthcare services refers to surgical, pharmacological, or physical therapies. Even if the purpose of treatment is unclear due to limited data collection, it can be inferred that those therapies have a positive effect on pain improvement. Therefore, pain-free later life can be feasible if proper treatment and management are provided. These results could only have been obtained through the panel data and trajectory analysis.

Despite the significance of this study, there are some limitations that should be considered in regard to interpreting the results. First, the effects of particular chronic diseases on pain could not be distinguished; consequently, the effects of specific diseases on specific regions of the body were not considered. Pain was analyzed comprehensively rather than with regard to specific areas of the body; therefore, this is an opportunity for further study. Second, the impact of outpatient treatment associated with pain could not be investigated due to no relevant information. Instead, we were forced to make inferences regarding the causal relationship; therefore, careful interpretation of the results is of necessity. Finally,

the intensity of pain is not considered in this study because there are no standard criteria for calculating a composite score that reflects the intensity of pain. These problems can be solved by establishing new criteria or by further studies related to specific pain.

In conclusion, persistent patterns of pain were found in most of elderly men and women, and these results imply the need for proper intervention before the pain becomes chronic because chronic pain has poor prognosis. A variety of factors have an association with pain; specifically, lack of physical activity, chronic disease, and depressive symptoms were the major risk factors regardless of gender, and gender-specific risk factors were found in the present study. In this regard, modifying these risk factors, as well as early intervention of pain is imperative, and establish policies pain management and treatment need to reflect the characteristics of the elderly. In addition, greater efforts are needed for monitoring and investigation of pain in order to relieve the socio-economic burden of pain.

CHAPTER V.

The Long-term Effect of Depressive Symptoms on All-cause Mortality in the elderly

Introduction

Depression is one of the mental illnesses among the elderly that should be urgently treated. In South Korea, one in three elderly people suffered from depressive symptoms according to a national survey (Korea Labor Institute, 2009); this figure is much more frequent compared to the longitudinal studies conducted in other countries (Barrett et al., 2011; Zivin et al., 2010). In addition to high prevalence, the reason why depression is important in the Korean elderly is the highest suicide rate. In general, depression is known to increase the risk of suicide (Harris & Barraclough, 1997; Yoshimasu et al., 2008); according to a study on Koreans, people with major depressive disorders were more likely to experience some kind of suicidal behaviors such as suicidal ideation, plan, and even attempts (Jeon et al., 2010). In addition, the age-standardized suicide rate among Korean elderly is about three times higher than the OECD average of 22 per 100,000 persons (OECD, 2011). Therefore, it should be addressed as a matter of urgency in South Korea which is stigmatized as the 'Republic of Suicide.' Suicide due to depression is a major problem in itself, but it also increases the overall mortality rate of the elderly.

Geriatric depression is commonly known to increase mortality; specifically, depression increases mortality includes all-cause, or related to specific diseases mortality (Lewis et al., 2011; St. John & Montgomery, 2009; Sun, Xu, Chan, Lam, & Schooling, 2013). However, depression is highly dependent on the socio-cultural context and there can be differences by race or country. Most of the previous studies mentioned above were conducted in Western countries, and there were few studies on Asians. Western countries have entered an aged society for a relatively long time,

but Asian countries, especially South Korea, took a very short time. Therefore, the health and welfare system cannot be the same for the elderly of the Western countries and those of Asian countries. In addition, even studies conducted in Western countries have also failed to identify positive correlations between depression and mortality. In this regard, it is expected that the unique relationship between depression and mortality in South Korea will be confirmed based on the higher prevalence of depression and suicide rate in the Korean elderly. Thus, the present study aimed to identify the long-term effect of depressive symptoms on all-cause mortality in Korean elderly.

Subjects and Methods

1. Data

The data used in the present study were drawn from the baseline (2006) through fifth wave (2014) surveys of the Korean Longitudinal Study of Ageing (KLoSA), which was consisted of South Korean adults aged 45 years and older living in households. The survey was designed to provide comprehensive data across the social, economic, and spiritual life of the elderly, and was conducted to produce basic data for effective social and economic policy making that reflects the aspects of aging in South Korea. The survey was conducted every two years since the baseline survey (2006). The population of KLoSA were selected using stratified multi-stage sampling in order to guarantee national representativeness. A total of 10,254 individuals who were interviewed using Computer-Assisted Personal Interviewing (CAPI) were participated in the baseline survey (2006). The second wave survey (2008) followed up 8,875 subjects (retention rate of the original population: 86.6%), the third wave survey (2010) followed up 8,229 subjects (retention rate of the original population: 80.3%), the fourth wave survey (2012) followed up 7,813 subjects (retention rate of the original population: 76.2%), the fifth wave survey (2014) followed up 7,467 subjects (retention rate of the original population: 72.8%).

The subjects were restricted to individuals aged 60 years or older based on the research purposes of the present study; thus, subjects under the age of 60 (n = 4,706) who completed the baseline survey were excluded. Additionally, the subjects

who did not respond the main explanatory variables (n = 47) were also excluded. Thus, 5,501 individuals (2,359 men and 3,142 women) were ultimately included in the present analyses. This study was approved by the Institutional Review Board of Seoul National University (IRB No. E1706/001-003).

2. Variables

2.1. Depressive symptoms

Depressive symptoms were measured with the Korean version of the 10-item Center for Epidemiological Studies Depression Scale (CES-D 10), a briefer version of the CES-D used worldwide. The CES-D was developed for epidemiological studies investigating depressive symptoms among the general population (Radloff, 1977). The CES-D 10 consists of 10 questions included in the original version: "I was bothered by things that usually don't bother me," "I had trouble keeping my mind on what I was doing," "I felt depressed," "I felt that everything I did was an effort," "I felt pretty good," "I felt fearful," "My sleep was restless," "I was generally satisfied," "I felt lonely," and "I could not get going" (Irwin *et al.*, 1999). Each item was measured using a four-point scale that reflects the severity of depressive symptoms in accordance with the frequency of each symptom during the past week: 0 (less than 1 day), 1 (1–2 days), 2 (3–4 days), and 3 (5–7 days).

In the present study, the responses were re-coded as 0 (less than 1 day) and 1 (1 or more days); scores for positive questions such as "I felt pretty good" and "I

was generally satisfied" were re-coded in the reverse manner. The range of the CES-D 10 scores is 0-10 points, and the cut-off value of 4 was used; the subjects with more than the cut-off value of CES-D 10 scores were defined as a depressed group. The Cronbach α coefficients for the CES-D 10 in each survey year were 0.80 (2006), 0.80 (2008), 0.82 (2010), and 0.85 (2012), which revealed similar or higher levels of internal consistency compared with a preceding study (0.80) (Irwin *et al.*, 1999).

2.2. Person-time variable

The person-time was calculated on a monthly basis based on the baseline survey point. The deceased participants were calculated the person-time using their date of death, and the person-time of the censored participants was calculated based on the point of last survey before the dropout. In the case of the participants who were surveyed until the last wave, the person-time was derived from the time of the last survey.

2.3. Baseline covariates

To adjust the variables that influenced the long-term effect of depressive symptoms, possible covariates such as age, education, marital status, household income, economic activity, social gathering, and pain were assessed. The subjects were divided into three groups according to age: those 60–69 years old, those 70–79 years old, and those 80 years or older. The level of education was divided into two

groups: primary school or lower and middle school or higher. Annual household income during the past year was determined using an open-ended question and then categorized into quartiles, and marital status was categorized as married or single. The subjects were also classified as employed or unemployed according to their current employment status. The subjects answered “Yes” (1) or “No” (0) to the questions about their social participation as attending social gatherings.

The subjects were also asked whether they had been diagnosed with a major chronic disease such as hypertension, diabetes, cancer, chronic pulmonary disease, liver disease, cardiac disease, cerebrovascular disease, and/or arthritis (degenerative or rheumatoid arthritis); people with one or more chronic diseases were classed as chronic disease patients. The subjects were asked whether they had pain in various parts of their body including the head, shoulders, arms, wrists, fingers, chest, abdomen, waist, hips, legs, knees, ankles, and/or toes; individuals with pain in one or more parts were included in the pain group.

2.4. Time-varying (Time-dependent) covariates

Later life is a period in which marital status may be changed due to the death of a spouse or the aging process causes deterioration of physical function or chronic diseases. For these reasons, time-varying covariates that are expected to affect the mortality because of changes in status over time should be considered in order to adjust the variables that influenced the long-term effect of depressive symptoms on the mortality. In the present study, marital status, current employment,

attending social gatherings, chronic disease, and pain were treated as time-varying covariates. The variables which were investigated prior to death or dropout were used in principle, however, the most recently investigated values were used to prevent errors due to missing values If the variables before death or dropout were missing.

3. Statistical analysis

Non-weighted frequencies, means, and standard deviations (SDs) were calculated for the explanatory variables to examine the general characteristics of the study population. The survey period was from the baseline survey (2006) to the fifth survey (2014), which is the most recent survey. Through the death data for each wave, the deceased participants were classified and the time of death was confirmed.

Survival curves were generated using Kaplan-Meier analysis in order to determine the differences according to depressive symptoms. The Cox proportional hazards regression was conducted to predict the risk of all-cause mortality associated with depressive symptoms at baseline. Two different Cox models were performed: 1) traditional Cox regression model with covariates at baseline (fixed covariates), and 2) time-varying Cox regression model with time-varying covariates. Both Cox models were divided into four sub-models according to controlling of covariates. Model I represents crude hazard ratios (HRs), and model II was adjusted for demographic variables (age, education, household income and marital status). Model III was controlled for demographic variables and social participation variables

(economic activity and social gathering), and model IV was adjusted for demographic, social participation, and medical condition variables (chronic disease and pain). All analyses were performed using SAS statistical software, version 9.4 (SAS Institute, Inc., Cary, NC).

Results

Table 5.1 presents the general characteristics of the study population according to gender. The mean aged was higher in women than in men. Women were more likely to have a lower level of education than men, such that the majority of women had a middle school education or lower. More than 90% of men retained a married status, while approximately the half of women were single. In addition, women suffered more from chronic diseases and pain than men. Men appeared to be more active in terms of social participation, such as attending social gatherings and school/hometown/ family reunions. Additionally, women were more likely to be depressed than men.

The different curves of survival probability due to depressive symptoms according to gender are presented in Figures 1 and 2. The scaled time represent the time of death. Men exhibited the different survival curves according to depressive symptoms; the group of people who are depressed was more likely to have lower survival probability than normal group (Figure 5.1). Women showed the same pattern as men even if the extent of decline is smaller than men (Figure 5.2). These differences according to presence or absence of depressive symptoms were statistically significant (Log-Rank p-value < 0.0001).

Table 5.1. General characteristics of study populations (N=5,501)

Variables at baseline	Men (n=2,359) *n* (%)		Women (n=3,142) *n* (%)	
Age				
60-69	1302	(55.2)	1566	(49.8)
70-79	842	(35.7)	1144	(36.4)
80<	216	(9.2)	432	(13.8)
Education				
Primary school or lower	1135	(48.1)	2587	(82.3)
Middle school or higher	1124	(51.9)	555	(17.7)
Marital status				
Single	212	(9.0)	1541	(49.1)
Married	2147	(91.0)	1601	(51.0)
Household income				
Q1	514	(21.8)	864	(27.5)
Q2	564	(23.9)	801	(25.5)
Q3	609	(25.8)	653	(20.8)
Q4	672	(28.5)	824	(26.2)
Economic activity				
Yes	783	(33.2)	358	(11.4)
No	1576	(66.8)	2784	(88.6)
Social gathering				
Yes	1258	(53.3)	1290	(41.1)
No	1101	(46.7)	1852	(58.9)
Chronic disease				
Yes	1303	(54.9)	2102	(67.0)
No	1057	(45.1)	1040	(33.0)
Pain				
Yes	1407	(59.6)	2729	(86.9)
No	952	(40.4)	413	(13.1)
Depressive symptoms				
Yes	755	(32.0)	1491	(47.5)
No	1604	(68.0)	1651	(52.6)

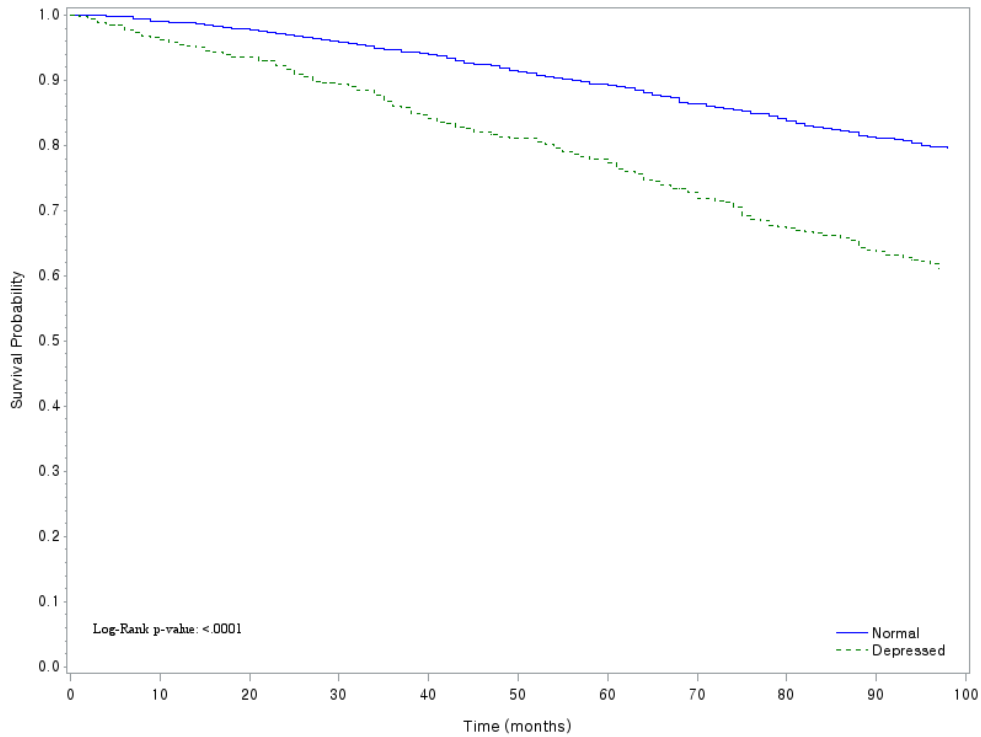

Figure 5.1. Kaplan-Meier overall survival curve for the mortality from all causes according to depressive symptoms in elderly men

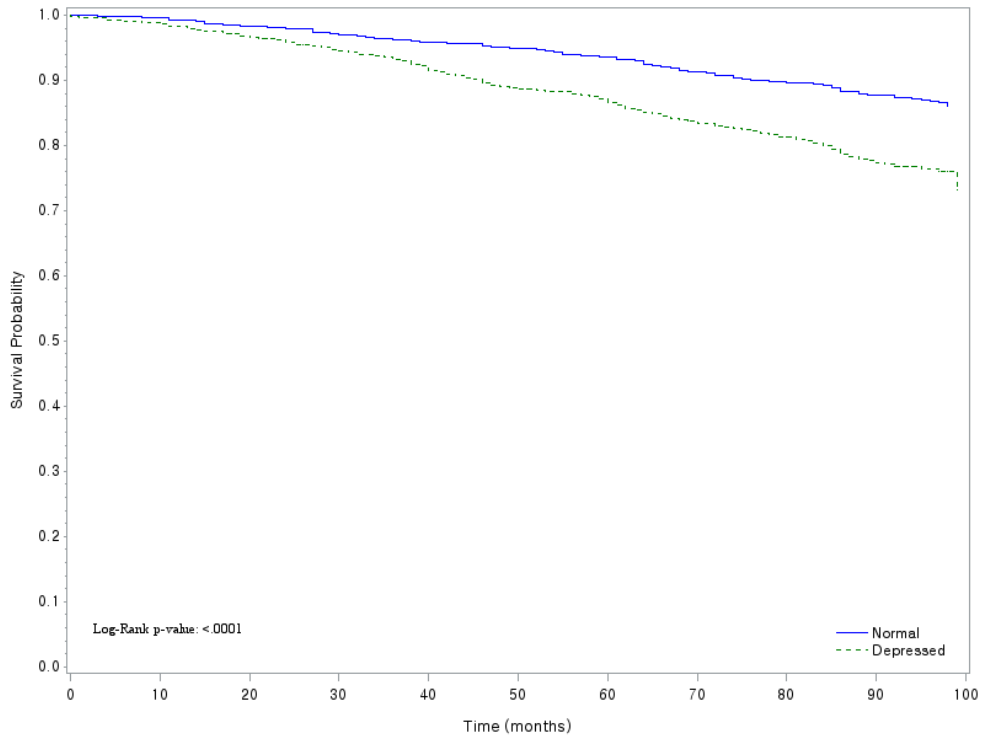

Figure 5.2. Kaplan-Meier overall survival curve for the mortality from all causes according to depressive symptoms in elderly women

Table 5.2 provides the hazard ratios (HRs) with traditional Cox model with fixed covariates used to determine the long-term effect of depressive symptoms on all-cause mortality according to gender. Compared with the crude HRs, the effect of depressive symptoms is greater in men than in women, but this trend was reversed after controlling the covariates. Despite the differences of extent, the effect of depressive symptoms was statistically significant regardless of adjustment. Table 5.3 shows long-term effect of depressive symptoms on all-cause mortality using time-dependent Cox model. The trend of HRs decreased by controlling the time-varying covariates was not different from that of traditional model.

Table 5.2. Hazard ratio estimates of death from Cox's Proportional Hazards Model

	Model I[†]		Model II[‡]		Model III[§]		Model IV[‖]	
Variables (Ref)	HR	95% CI[*]	HR	95% CI	HR	95% CI[*]	HR	95% CI[*]
Men								
Depressive symptoms (No)	2.19	(1.85-2.58)***	1.69	(1.42-2.01)***	1.60	(1.34-1.91)***	1.53	(1.28-1.83)***
Age			2.23	(1.98-2.52)***	2.05	(1.81-2.33)***	2.04	(1.80-2.31)***
Education (Primary school or lower)			0.91	(0.77-1.10)	0.91	(0.76-1.09)	0.89	(0.75-1.07)
Household income (Q1)			0.95	(0.87-1.02)	0.98	(0.91-1.06)	0.98	(0.91-1.06)
Marital status (Single)			0.80	(0.62-1.03)	0.82	(0.64-1.06)	0.82	(0.65-1.06)
Economic activity (No)					0.63	(0.51-0.79)***	0.66	(0.52-0.82)**
Social gathering (No)					0.75	(0.63-0.89)*	0.75	(0.63-0.89)**
Chronic disease (No)							1.41	(1.18-1.68)**
Pain (No)							1.04	(0.87-1.25)
Women								
Depressive symptoms (No)	1.91	(1.60-2.28)***	1.62	(1.35-1.94)***	1.59	(1.32-1.90)***	1.61	(1.34-1.94)***
Age			3.09	(2.70-3.52)***	2.84	(2.48-3.26)***	2.83	(2.47-3.24)***
Education (Middle school or lower)			0.66	(0.47-0.94)*	0.67	(0.47-0.94)*	0.67	(0.47-0.94)*
Household income (Q1)			1.01	(0.93-1.09)	1.02	(0.94-1.10)	1.01	(0.94-1.09)
Marital status (Single)			0.78	(0.63-0.96)*	0.79	(0.64-0.97)*	0.79	(0.64-0.97)*
Economic activity (No)					0.37	(0.21-0.63)**	0.36	(0.21-0.62)**
Social gathering (No)					0.71	(0.59-0.87)**	0.72	(0.59-0.87)**
Chronic disease (No)							0.90	(0.75-1.09)
Pain (No)							0.96	(0.72-1.28)

[*]p-value<.05, [**]p-value<.001, [***]p-value<.0001; [†]Model I: unadjusted HRs; [‡]Model II: adjusted for demographic variables; [§]Model III: same as Model II + Social participation variables; [‖]Model IV: same as Model III + Medical condition variables

Table 5.3. Hazard ratio estimates of death from Cox's Proportional Hazards Model with time-varying explanatory variables

	Model I[†]		Model II[‡]		Model III[§]		Model IV[ǁ]	
Variables (Ref)	HR	95% CI[*]	HR	95% CI	HR	95% CI[*]	HR	95% CI[*]
Men								
Depressive symptoms (No)	2.19	(1.85-2.58)[***]	1.74	(1.46-2.07)[***]	1.61	(1.35-1.92)[***]	1.62	(1.36-1.93)[***]
Age			2.27	(2.01-2.57)[***]	2.05	(1.81-2.32)[***]	2.05	(1.81-2.33)[***]
Education (Primary school or lower)			0.92	(0.77-1.09)	0.88	(0.74-1.05)	0.89	(0.74-1.06)
Household income (Q1)			0.94	(0.87-1.02)	0.97	(0.89-1.05)	0.97	(0.89-1.05)
Marital status (Single)			1.12	(0.89-1.43)	1.14	(0.90-1.44)	1.14	(0.90-1.45)
Economic activity (No)					0.70	(0.55-0.90)[*]	0.69	(0.54-0.89)[*]
Social gathering (No)					0.58	(0.48-0.69)[***]	0.57	(0.48-0.69)[***]
Chronic disease (No)							0.90	(0.74-1.09)
Pain (No)							1.03	(0.86-1.23)
Women								
Depressive symptoms (No)	1.91	(1.60-2.28)[***]	1.66	(1.38-1.98)[***]	1.62	(1.35-1.94)[***]	1.69	(1.41-2.03)[***]
Age			3.40	(2.98-3.89)[***]	3.13	(2.73-3.59)[***]	3.01	(2.62-3.45)[***]
Education (Middle school or lower)			0.64	(0.45-0.90)[*]	0.67	(0.47-0.95)[*]	0.68	(0.48-0.96)[*]
Household income (Q1)			1.01	(0.94-1.09)	1.01	(0.93-1.08)	1.00	(0.93-1.08)
Marital status (Single)			1.14	(0.92-1.43)	1.15	(0.92-1.43)	1.15	(0.92-1.44)
Economic activity (No)					0.42	(0.23-0.75)[*]	0.40	(0.22-0.71)[*]
Social gathering (No)					0.61	(0.50-0.74)[***]	0.61	(0.50-0.74)[***]
Chronic disease (No)							0.62	(0.51-0.75)[***]
Pain (No)							0.94	(0.73-1.20)

[*]p-value<.05, [**]p-value<.001, [***]p-value<.0001; [†]Model I: unadjusted HRs; [‡]Model II: adjusted for demographic variables; [§]Model III: same as Model II + Social participation variables; [ǁ]Model IV: same as Model III + Medical condition variables

Discussion

The primary purpose of the present study was to determine the long-term effect of depressive symptoms on all-cause mortality in the elderly. According to survival curves related to all-cause mortality, the depressed participants were more likely to have a lower survival probability than the normal participants in both genders. In the perspective of the extent, there were statistically significant effects of depressive symptoms on the mortality in both genders regardless of the type of covariates although the effect sizes were declined after controlling for covariates.

The main finding of the present study that depressive symptoms has a negative effect on mortality in the elderly was consistent with those found in the previous studies (Barefoot & Schroll, 1996; Murphy et al., 2015; Mykletun et al., 2009; St. John & Montgomery, 2009; Wada et al., 2011). However, it is controversial whether the mortality is affected by depressive symptoms; some of the previous studies failed to determine this association between depressive symptoms and mortality (Miu & Chan, 2011; Thomas, Kelman, Kennedy, Ahn, & Yang, 1992; Vogt, Pope, Mullooly, & Hollis, 1994). In addition, the statistical significances disappeared after adjusting the independent variables in the previous study (Hamer, Bates, & Mishra, 2011), or were different as the age group of the study participants (Rapp, Gerstorf, Helmchen, & Smith, 2008) even in the earlier studies which showed similar results to this study. Therefore, statistically significant associations of the present study regardless of adjustment indicated that there is a high risk for depressive symptoms in Korean elderly.

These different results can be explained in that depressive symptoms are dependent on socio-cultural contexts; in other words, depression was influenced by the environments in which the elderly were faced with (Kleinman, 2004). In particular, there are different results depending on ethnicity even in a same country (Lewis et al., 2011), and different aspects of depression may appear depending on the country even within the same race (Kleinman, 2004). Culture is closely associated with biological, psychological, economical, and political issues, and lack of understanding of cultural issues is one cause of unmet needs for health care (Kleinman, 2004). Therefore, understanding the cultural causes of depression may reduce the risk of mortality from depression, and this is another reason why researches with the representative samples from each country or race should be conducted.

In terms of the effect of covariates on the association between depressive symptoms and all-cause mortality, the first thing to be confirmed was the age effect. It is not debatable that the mortality rate increases with age. However, the important implication of this study is that the effect of age was decreased when adjusted for other risk factors. This finding means that the risk of mortality associated with age could be reduced by improving other risk factors although the increase in age cannot artificially prevented. In the case of marital status, the traditional Cox model showed a lower risk of mortality in older women, but this effect disappeared in the time-varying Cox model. This is presumed to be related to the higher life expectancy of women and the long-term of living alone. Therefore, it is necessary to take measures to prevent adverse health outcomes induced from the death of a spouse known as the most extreme stressor. In addition, the protective effect of social participation on the

risk of mortality was confirmed regardless of gender or analysis model. However, the protective effect of social gathering was increased compared to economic activity in the time-varying Cox model, which is regarded to be because later life is the period retiring from main occupation. Lastly, chronic diseases have been shown to reduce mortality risk when analyzed with the time-varying covariates. These results do not imply that chronic diseases have a preventive effect on the reduction of mortality risk, but are considered to be because chronic diseases need an induction period from the diagnosis of diseases to the death.

According to a systematic review, the majority of studies used gender as an adjustment variable, and only a few studies had confirmed gender differences of depressive symptoms (Schulz, Drayer, & Rollman, 2002). In addition, studies with statistically significant differences by gender showed higher risk of mortality for men (Schulz et al., 2002); the results of the present study were distinct from the previous studies in that women had a higher risk of mortality induced from depressive symptoms. It is generally known that there are gender differences in relation to depressive symptoms (Nolen-Hoeksema et al., 1999); therefore, analysis should be conducted according to gender especially in Korea since the risk factors of the elderly exposed during the life course were different by gender

The present findings have several policy implications; decreasing the impact of depressive symptoms due to the adjustment of modifiable variables implied the effectiveness and possibility of intervention. The explanatory variables were divided into three categories: demographic, social participation, and medical condition variables. First, demographic variables which were hard to be modified

were used for adjustment, and these variables impeded the effect of depressive symptoms on the mortality in both genders. Next, social participation and medical condition, as modifiable risk factors, were included for adjustment, and the effect of these variables showed differences by gender. In elderly men, it can be seen that the influence of depressive symptoms on the mortality were reduced as the explanatory variables were further adjusted, whereas there was no significant change in the influence of the explanatory variables in women. It can be explained that the effect of intervention of modifiable variables is expected to be higher in men than women. In other words, the effect of intervention by the provision of policies for promoting social participation or healthcare services seem to be more effective in elderly men. In addition, the influence of the demographic variables was greater in elderly women. The intervention on demographic variables are more difficult to approach than other modifiable factors; thus, a more attentive and complex approaches are expected for health promotion.

Despite the significance of the present study, there are several limitations that should be considered. Total mortality was considered in this study. This is because only limited information was available. In the case of survey for the deceased participants, it was collected through interview of the proxy, in particular, there was no disease classification code for the cause of death, but only the approximate cause of death. As a result, the association between depressive symptoms and the mortality induced from specific cause of death could not be confirmed. If these associations are taken into account in further studies, it may help to understand the mechanism leading to mortality in depressive symptoms.

In conclusion, the present study has demonstrated that the depressive symptoms affect the increased risk of all-cause mortality. Particularly, it has been confirmed that the risk of mortality associated with depressive symptoms was reduced by modifiable factors such as social participation. Although the extent of its impact varies by gender, the protective effect of social participation has been confirmed in common; therefore, spatial and policy environment should be created for the elderly to participate in society. In addition, these findings will contribute to the establishment of policies to reduce mortality rate, and further, removal of the stigma of ‘Republic of suicide.’

CHAPTER VI.

Discussions

The present study was conducted to determine changing patterns and associated risk factors in the health status of the elderly from various aspects: perceived overall health, mental health, physical health, and mortality. The first study demonstrated the association between changes of SRH as the perceived health status and risk factors during the life course among the elderly. The second study determined the causal relationship between changes of depressive symptoms and risk factors affecting the changes in the older population. The third study indicated the causal association between changing patterns of pain and related risk factors in the elderly. The last study confirmed the association between depressive symptoms and total mortality as the final stage of aging. Group-based trajectory model and survival analysis were used and these analyses were performed according to gender in order to determine the gender differences.

Self-rated health is the indicator that measures perceived health status of individuals with a single question, and it is used in various fields of epidemiologic research. SRH can infer the integrated health status encompassing biological, psychological, and social perspectives that cannot be identified by external observers (Miilunpalo et al., 1997). In terms of being able to check the overall health status of the elderly, identifying changing patterns of SRH and related risk factors during the life course are very important and the results were determined in Chapter Two. In the perspectives of gender differences, it was identified in changing patterns of trajectories. Chronic diseases found in later life and undernourishment experienced in childhood were found to be major risk factors for the decline of SRH in both genders, and household income, the longest occupation, and basic livelihood security service were associated with lower SRH only in women. According to these results,

this study demonstrated that the health status in later life is the cumulative result of the various experiences undergone during the life course, and initial values of health status should be measured and monitored.

Depressive symptoms are one of the most important health problems among the elderly since it is accompanied by a wide variety of negative effects such as suicide; especially, South Korea was stigmatized as a republic of suicide with higher suicide rate among the elderly. Therefore, identifying the current situation and risk factors of depressive symptoms as one of important causes of elderly suicide is crucial to take off the stigma. The results were presented in Chapter Three; common risk factors were older age, pain, poor SRH, and lower QoL. Moreover, it was confirmed that gender differences in related risk factors in addition to changing patterns of depressive symptoms; employment status in elderly men, and social participation in elderly women had a protective effect on depressive symptoms. According to these results, this study indicated that the maintenance of physical health is also beneficial in maintaining mental health. Also, employment policies that reflect the physical and mental conditions of the elderly and social welfare policies that allow the formation of social network among the elderly are crucial to improve mental health status in the elderly.

Pain leads to discomfort in daily life, and also causes a number of pernicious effect on health among the elderly. Despite these risks, prejudices against pain that it is part of the natural aging process are still prevailed on the whole society. Nevertheless, investigating actual conditions and risk factors of pain is critical for active aging since pain significantly decreases the QoL in later life resulting in

dependent assisted living. The results were demonstrated in Chapter Four; manual work condition, married status, physical inactivity, depressive symptoms, injuries, poor SRH, and outpatients were the common risk factors of pain in men, and physical inactivity, chronic diseases, and poor SRH were the major risk factors in women. The findings of the present study indicated that the guidelines of treatment and management of pain are most imperative reflecting special conditions of the elderly, and that investigation and monitoring on actual conditions of pain are needed in order to measure the socio-economic burden of pain and establish policies.

Depression increases the risk of all-cause mortality and this is generally accepted. However, depression is highly dependent on the socio-cultural context; the different findings can be derived depending on race or country. Thus, the unique association between depression and mortality in South Korea will be confirmed based on the higher prevalence of depression and suicide rate. The results were demonstrated in Chapter Five; depressive symptoms were found to be an independent risk factor affecting the long-term survival probability of the elderly regardless of gender or analysis model, and the effect continued after controlling for covariates. According to these finding, the protective effect of modifiable variables, especially social participation, was outstanding; therefore, the effect of intervention by the provision of policies for promoting social participation seem to be effective to reduce mortality risk associated with depressive symptoms. In addition, these findings will contribute to the establishment of policies to reduce mortality rate, and further, removal of the stigma of 'Republic of suicide.'

Group-based trajectory analysis was performed to confirm the health

trajectories and risk factors among the elderly. The statistical method determined that health status changed diversely; there were various groups such as the normal, the chronic, the worsened, and improved groups. Trajectory analysis confirms the trajectories that actually exist exploratively; in this regard, it may reflect the reality of health status in the elderly more than other methods. Thus, these aspects can be described as the greatest advantage of the trajectory analysis. In addition, this method can demonstrate modifiable risk and protective factors of negative health outcomes through multinomial modeling strategy; finding modifiable factors are very crucial for healthy aging of the elderly.

Despite the heterogeneity of explanatory variables in each study, chronic disease was shown to be a major common risk factors that aggravate health outcomes in the present study. Treatments and managements of chronic diseases are important, however, prevention is more critical in order to reduce the burden of chronic disease. Therefore, managements of chronic disease are necessary to ensure that the health status does not be worsened in the elderly; the education program on the importance of chronic disease management should be expanded for this purpose. Also, there is a need for early intervention to prevent the morbidity of chronic disease in young and middle-aged adults; for achieving this objective, it is necessary to develop and promote appropriate prevention programs for these people.

In addition, the protective effect of social participation was also outstanding in this study. Social participation, characterized by economic activity and social gathering, has been shown, not only to reduce the negative effects of depressive symptoms regardless of gender, but also to alleviate the risk of mortality associated

with depressive symptoms. Therefore, it is expected that the risk of depressive symptoms and even mortality related to depressive symptoms could be prevented if the environmental conditions improved so that the elderly can form their own network and communicate with each other.

However, there were explanatory variables representing contradictory correlation in each study. For example, manual work had an adverse effect on pain, but employment itself was shown to be a protective effect on depression in the elderly men. Also, SRH was negatively influenced by unemployment as a housewife, but pain was positively affected by unemployment. Moreover, association between health outcomes was also observed in the present study; good SRH had a positive effect on both depression and pain, and there was an interconnection between depression and pain. Thus, health promotion of the elderly requires a very comprehensive approach with careful consideration of the various association formed between modifiable factors and health outcomes. In addition, this is a great strength of the present study in terms of that it enabled the integrated discussion regarding association between each explanatory variables and health variables.

In the present study, all analyses were performed by dividing gender in order to verify the results which are differed due to gender. When trying to understand the health status of the Korean elderly, there are several contemporary contexts which must be considered: the Japanese colonial era, the Korean war, and the period of rapid industrialization (H.-S. Lee, 2006). Korean elderly is the generation that experienced both the colonial era and the war during their childhood and adulthood, and rapid economic changes caused by industrialization in their

middle age; at that time, the majority of Koreans have experienced absolute poverty, resulting in the vicious cycle of lack of education, early marriage, and poverty (H.-S. Lee, 2006). Survival itself is the most important thing in their childhood, and poverty in childhood meant deprivation of educational opportunities. Especially, Korean women could not have any priority, and lived with oppression and discrimination in the historical background that the patriarchal ideology of a patrilineal society prevails (E. Kang & Han, 2002); deprivation of life chances such as lack of education led them back into poverty (H.-S. Lee, 2006). Poverty also affected the marriage age; for instance, poorer women married young, but, poorer men married late (E. Kang & Han, 2002). In addition to the differences in average life expectancy of men and women, the added age difference between the couple resulted in early widowed women, and women who were left alone had to start social activities to reduce hardships of life. However, lack of work experience and lower education were the biggest obstacles to economic activity, as a result, women suffered from an unstable position and lower wages (H.-S. Lee, 2006). In the matter of survival, health is only a secondary concept, and these discriminatory and negative experiences are postulated as the cause of different results in a change of health status. Therefore, the studies of the elderly in Korea were to take into account for gender differences because of these historical backgrounds.

This study has several public health and policy implications. The present study primarily demonstrated the long-term life course effect of childhood or adulthood exposures on subjective health status on old age, and secondarily confirmed changes in the health status such as depressive symptoms and pain after entering old age. Finally, the effect of depressive symptoms, as an important health

problem in the elderly, on mortality was investigated. According to the results of this study, there were groups with chronically unhealthy conditions, and with rapidly changed health status among the elderly. Also, one of the health outcomes can be a risk factor for other health outcomes; for example, pain was a risk factor for depressive symptoms, and vice versa. Therefore, an interventional approach related to each risk factors is needed to break the vicious cycle of depressive symptoms and pain. In addition, social participation, such as economic activity or social gatherings, has been shown to alleviate depressive symptoms, and further reduce the impact of depressive symptoms on the risk of mortality. Therefore, political, institutional, and environmental conditions should be created that can promote social participation. These implications can be confirmed only through comprehensive studies like the present one.

In conclusion, the present study empirically studied the complicate association between various health conditions and their risk factors, and indicated the applicability of new methodology in the field of epidemiology of aging which utilize epidemiological and gerontological methods to understand the complex aging traits. Identification of health trajectories through the GBTM is expected, that will provide information that cannot be found with conventional methods, and it can increase the utilization of longitudinal study data. In addition, identification of the current situation and risk factors of health status among the elderly through a multifaceted approach to the health status of the elderly will be the first step towards the settlement of the downsides that may arise due to rapid aging of Korea.

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국문초록

서론

인구 고령화는 전 세계적으로 문제가 되고 있다. 특히 한국의 급속한 고령화는 타의 추종을 불허하며, 2050년에는 세계에서 두 번째로 고령 인구가 많은 국가가 될 것으로 추계되고 있다. 고령화로 인한 국가적 부담을 줄이기 위해서는 노인의 건강상태와 관련 위험요인을 파악하는 것은 매우 중요하다고 할 수 있다. 따라서, 본 연구는 첫째, 주관적 건강상태와 생애과정동안의 사회경제적 변수간의 연관성을 확인하고, 둘째, 우울증상의 변화 양상과 이러한 변화에 영향을 미치는 위험요인을 확인하며, 셋째, 통증의 변화 양상과 관련 위험 요인을 조사하고, 마지막으로 우울증상이 전체 사망률에 미치는 장기적 영향에 대해서 확인하고자 한다.

방법

첫째로, 1,000명의 노년층이 무작위추출법에 의해 선정되었고, 심층 면접과 공공 자료 분석을 통해 개발된 설문지를 사용하여 대면 면담을 실시했다. 주관적 건강상태와 생애 과정 동안의 사회경제적 상태를 나타내는 변수, 그리고 인구학적 변수 등이 분석에 포함되었다. 둘째로, 2006년부터 2012년까지 한국고령화연구패널에 참여한 60세 이상 노인 3,667명 (남성 1,566명, 여성 2,101명)이 연구대상으로 포함되었다. 셋째로, 2006년부터 2014년까지 한국고령화연구패널에 참여한 60세 이상 노인 2,820명 (남성 1,171 명, 여성 1,649 명)이 연구대상으로 포함되었다. 마지막으로, 2006년부터 2014년까지 한국고령화연구패널에 참여한 60세 이상 노인 5,502 명 (남자 2,360 명, 여자 3,142 명)이 연구

에 포함되었다. 2장에서 4장까지의 연구에서는 건강 결과에서의 적절한 하위 그룹을 선정하고 건강 결과의 변화 양상을 확인하기 위해 Group-based trajectory model (GBTM)을 사용하였고, GBTM에서 도출된 결과를 바탕으로 다항회귀분석을 실시하여 건강상태의 변화 양상과 관련 위험요인을 확인하였다. Kaplan-Meier 분석과 Cox Proportional Hazard Model을 사용하여 우울 증상과 전체 사망률 간의 연관성을 확인하였다.

결과

첫째로, 남성노인에서는 어린 시절 동안 굶주림을 경험하고 만성질환을 앓고 있는 노인들이 더 낮은 주관적 건강상태를 나타낼 확률이 높은 것으로 나타났다. 여성노인에서는 어린 시절의 굶주림 경험과 낮은 가구소득, 가정주부로서의 역할, 그리고 만성질환의 이환이 낮은 주관적 건강상태를 나타내게 하는 위험요인으로 확인되었다. 둘째로, 남녀 모두에서 만성질환, 주관적 건강상태, 그리고 통증이 우울 증상과 관련이 있는 것으로 나타났다. 그리고 남성 노인에서는 경제활동참여로서의 직업이, 여성 노인에서는 사회 참여활동이 우울증상을 통계적으로 유의미하게 감소시키는 것으로 나타났다. 셋째로, 남녀 모두에서 신체활동 부족, 만성질환, 그리고 우울증상이 통증의 위험과 관련이 있는 것으로 나타났고, 최장 직업으로서의 단순노동, 손상 경험, 그리고 결혼 여부가 남성 노인에서 통증과 연관이 있었으나 여성 노인에서는 이러한 연관성이 확인되지 않았다. 반면, 여성 노인에서는 낮은 가구소득이 통증의 위험 요인인 것으로 나타났다. 마지막으로, 우울증상은 전체 사망률에 부정적인 영향을 미치고, 여성 노인이 남성 노인에 비해 우울증상의 영향이 더 큰 것으로 나타났다. 남성 노인의 경우 사회 참여나 의료 서비스와 같이 중재 가능한 위험요인에 영향을 받을 가능성이 더 높았으며, 여성 노인은 인구사회학적 변수의 영향을 받을 가능성이 더 높은 것으로 나타났다.

결론

노년기의 건강상태는 생애과정에서 노출된 다양한 경험들이 누적된 결과이다. 그러므로 이를 확인하기 위해서는 건강상태의 초기값을 측정하고 모니터링해야 한다. 또한 신체적 건강상태를 유지하는 것은 정신 건강을 유지하는데 도움이 된다고 할 수 있다. 더불어 노인의 정신 건강을 개선하기 위해서는 노인 개개인의 신체적, 정신적 상태를 반영한 고용정책이 수립되어야 하고, 노인들이 그들의 사회적 네트워크를 형성할 수 있도록 하는 사회 복지 정책이 중요하다고 할 수 있다. 그리고 노인 개개인의 상황이 반영된 통증 관련 치료와 관리 지침이 필요하며, 통증의 사회경제적 부담을 측정하고 관련 정책을 수립하기 위해서는 통증의 실태에 대한 조사와 모니터링이 필요하다. 마지막으로, 우울증상은 전체 사망률의 위험을 증가시키며, 그 영향력의 정도는 성별에 따라 다르게 나타난다. 그러므로, 성별에 따라 다른 중재 접근이 필요하다고 할 수 있다.