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The Lifetime Cost of Dementia

- Prevention and Management

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I Introduction

I Introduction

Dementia is one of the highest-priority healthcare issues around the world today. According to the World Health Organization (WHO, 2012),[1] there will be approximately 20 billion seniors aged 60 and older by 2050, and considering the brisk pace at which population aging is progressing worldwide, the number of dementia patients will likely increase rapidly as well. As of 2015, there were already 46.8 million patients worldwide, and that number is projected to rise to 74.7 million by 2030 and 131.5 million by 2050 (World Alzheimer's Report, 2015).[2]

The World Bank's analysis of the distribution of dementia patients worldwide by national income level estimates that the number of patients in high-income countries will likely rise from 19.5 million in 2015 to 27.95 million in 2030 and further to 42.18 million in 2050 (Table 1-1). The prevalence rate of dementia in the Asia-Pacific high-income (APHI) countries, including South Korea, was seven percent in 2015, with the number of patients in the region expected to increase by 56 percent by 2030 and 115 percent by 2015.[3]

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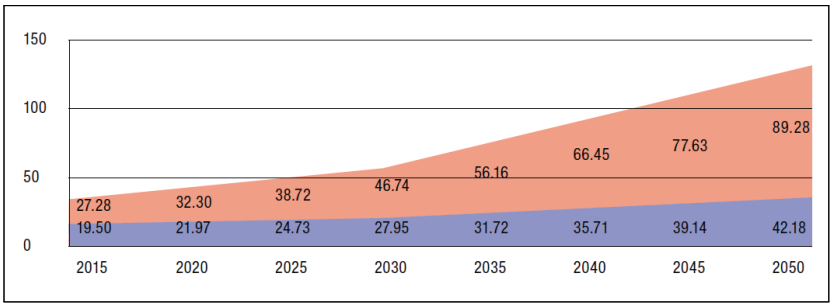
1) WHO, Dementia: A public health priority. 2012.
2) World Alzheimer's Report 2015. London, Alzheimer's Disease International, 2015. pp22-23.

[Figure 1-1] Projections on the Increasing Number of Dementia Patients Worldwide

(Unit: millions of people)



Note: The figures along the bottom are for high-income countries, while those along the top are for low- to middle-income countries.
Source: World Alzheimer's Report (2015)

〈Table 1-1〉 Distribution of Dementia Patients by National Income Level

(Unit: millions of people)

World Bank income group	Number of patients							
	2015	2020	2025	2030	2035	2040	2045	2050
Low-income	1.19	1.42	1.68	2.00	2.41	2.90	3.55	4.35
Lower middle-income	9.77	11.52	13.72	16.35	19.48	23.12	27.18	31.54
Upper middle-income	16.32	19.36	23.33	28.39	34.28	40.43	46.90	53.39
High-income	19.50	21.97	24.73	27.95	31.72	35.71	39.14	42.18
Worldwide	46.78	54.27	63.45	74.69	87.88	102.15	116.78	131.45

Source: World Alzheimer's Report (2015)

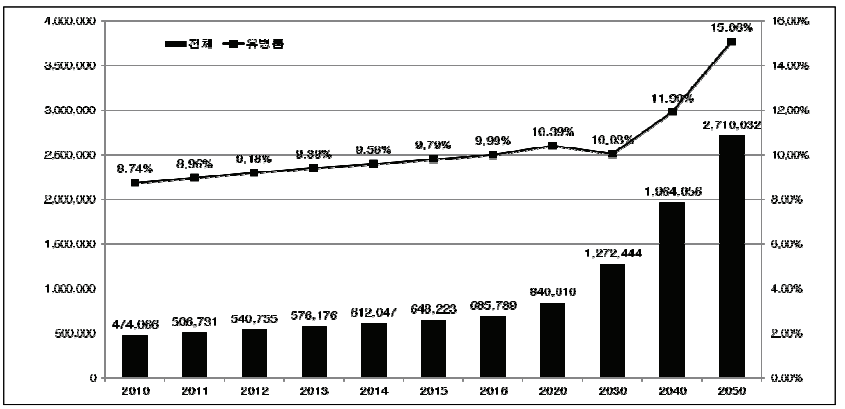
According to a Korean study on the prevalence rate of dementia in Korea as of 2012, the rate reached 9.18 percent among seniors aged 65 and older, affecting a total of 541,000

3) World Alzheimer's Report 2015. London, Alzheimer's Disease International, 2015. pp.24.

patients (156,000 male and 385,000 female patients). The study forecasts that the prevalence rate will rise steadily to almost 15 percent by 2050 (MOHW-SNUBH, 2013).

[Figure 1-2] Dementia among Seniors 65 Years of Age and Older: Prevalence Rate and Projections

(Unit: number of people)



Source: Ministry of Health and Welfare (MOHW)-Seoul National University Bundang Hospital (SNUBH) (2013), Survey on the Prevalence Rate of Dementia 2012

〈Table 1-2〉 Forecasts on the Number of Dementia Patients in Korea

(Units: 1,000 people, %)

	2015	2020	2025	2030	2050
Total population	50,617	51,435	51,972	52,160	48,121
Seniors 65+	6,624	8,084	10,331	12,691	17,991
Proportion of seniors (%)	13.1	15.7	19.9	24.3	37.4
dementia patients*	648	840	1,008	1,272	2,710
Prevalence rate (%)*	9.8	10.4	10.2	10.0	15.1

Source: Statistics Korea, Projections on the Future Korean Population; MOHW-SNUBH (2013)*

The medical cost of dementia has been growing rapidly in Korea, from KRW 41.5 billion in 2004 to KRW 452.8 billion in 2009 and further to an astonishing KRW 1.0455 trillion in 2013. And the cost is expected to continue increasing in the future (NHIS, National Health Insurance Statistical Yearbooks). As the number of dementia patients increases, the medical and socio-economic costs of treating and caring for these patients will grow as well.

This study estimates the social cost of dementia in Korea, and explores policy measures designed to accommodate the needs of individuals at different points of time in their lives to ensure the effective prevention and management of the disease.

To this end, this study first surveys the existing literature on dementia and identifies major issues. It then estimates the prevalence rate of dementia in Korea, using the National Health Insurance Service (NHIS)'s National Health Insurance (NHI) cohort data (2002 to 2013) and elderly cohort data (2002 to 2013), and examines dementia-related pathological indicators, including the related prevalence and mortality rates.

This study then performs a network analysis to determine, quantitatively, the distribution of other complex and chronic conditions that accompany dementia in patients. The Pagerank-Index is used in this network analysis.

In addition, the lifetime medical cost of dementia patients is

estimated using the Markov cohort simulations. The Markov model is used in healthcare analyses to simulate and understand how certain diseases occur and progress together in certain patient groups until the patients' death. This study runs the Markov cohort simulations to estimate the costs associated with dementia that the NHIS and individual patients (or their families) will have to bear over the next five or 10 years.

This study also analyzes the expected positive effects of effectively managing the risk factors of dementia. The seven major risk factors of dementia—patients' education levels, obesity and hypertension under the age of 65, physical inactivity, smoking, diabetes, and depression—are analyzed in terms of their contributions to the prevalence of dementia. The decrease in the number of dementia patients achieved by reducing each of these risk factors by 10 percent is also estimated. Finally, this study analyzes the current status of the public dementia prevention and management programs and suggests possible improvements.

II

The previous studies

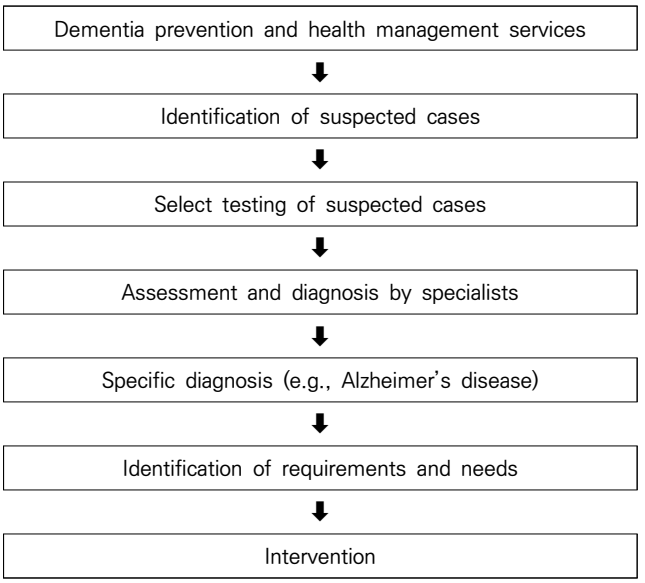
II The previous studies

The WHO's International Classification of Diseases (ICD) 10 defines dementia as a syndrome arising from chronic or progressive damage to the brain that affects multiple parts of the cerebral cortex involved in memory, thinking, orientation, understanding, calculation, learning, language, and judgment. For a patient to be diagnosed with dementia, he or she must have suffered debilitation that has reduced the daily activities in which he or she is able to engage, without prominently clouding his or her consciousness, for a period of at least six months (Kim et al., 2012).[4)]

The Korean government provides preventive care for the entire population, strives to identify and diagnose suspected cases of dementia early on, and seeks to provide appropriate, local community-based intervention, including required medical care, with the aim of minimizing the burden of caregivers.

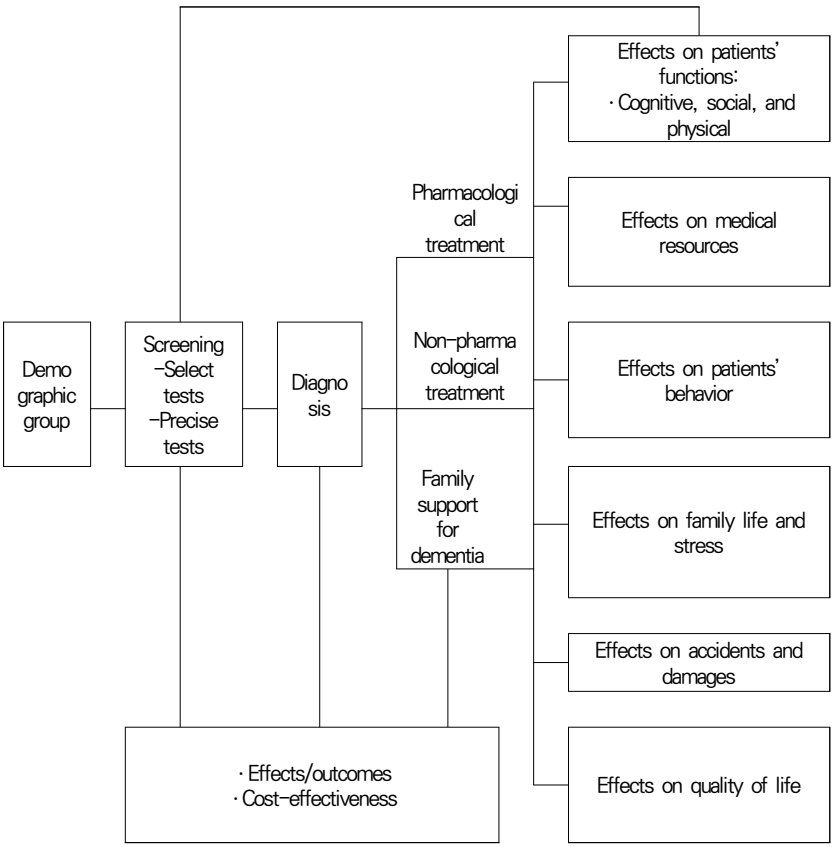
4) Kim, G., Kwak, G., and Kim, B. et al. (2012), Survey on the Prevalence Rate of Dementia 2012, MOHW-SNUBH (2012).

[Figure 2-1] Dementia: Diagnosis and Treatment



Dementia is not just a disease, as it involves multiple complex issues across diverse areas of people's lives and policymaking. Figure 2-2 presents some of the major issues involved in dementia care.

[Figure 2-2] Major Issues of Dementia Care



In dementia management, it is very important to detect and diagnose dementia patients early on. A central issue in public health policymaking today is how to effectively screen suspected patients under the age of 65 (WHO, 2012).[5]. Debates

5) WHO, Dementia: A public health priority. 2012.

continue as to the specifics of the screening methods, such as select and precise tests, and which of the diagnostic tools should be used. Other issues being discussed include the effectiveness of dementia care and family support measures, the cost-effectiveness of care, and the appropriateness if intervention strategies.

According to the WHO's "Dementia: a public health priority (2012)," there were 35.6 million dementia patients worldwide in 2012, and that number was expected to double to 65.7 million in just two decades, or by 2030, and quadruple to 115.4 million by 2050.

In 2010, the cost of dementia worldwide was estimated to be USD 604 billion. In high-income countries, informal care accounted for almost 45 percent of the total cost of dementia, and formal care, 40 percent. Direct medical costs amounted to only 15 percent.

Hurd et al. (2013) estimated the monetary cost of dementia in the United States, concluding that care for each patient costs USD 5,600 (approximately KRW 6 million) a year.

The Health Insurance Review and Assessment Agency (HIRA)'s statistics on the medical costs of the NHI in 2013 shows that Alzheimer's disease was by far the costliest of the 10 major diseases affecting seniors aged 65 and older, as of 2013, incurring KRW 10.92 million per patient in medical costs per year. Of the 10 diseases compared, Alzheimer's disease topped

the list in all areas except number of patients, including total medical cost, number of hospitalization days, cost per patient, and rate of increase in medical costs (Kim et al., 2014).[6)]

Table 2-8 below provides a breakdown of the economic cost of dementia per patient. As of 2010, the average cost per patient was KRW 18.51 million, of which 53.4 percent was direct medical costs; 32.7 percent, direct non-medical costs; 13.0 percent, long-term care costs; and 1.0 percent, indirect costs. As of 2010, the total economic cost of dementia was estimated to be KRW 8.7 trillion (MOHW, 2011).

6) Kim, G. et al. (2014), Preliminary Planning for the Establishment of a National Master Plan for Dementia Care, SNUBH.

〈Table 2-1〉 Annual Economic Cost of Dementia per Patient (2010)

Type	Cost item	Cost per patient (KRW)	%
Direct costs	Direct medical costs		
	Medical costs	8,607,990	46.5
	Co-payments for prescriptions	1,271,311	6.9
	Direct medical costs	9,879,301	53.4
	Direct non-medical costs		
	Cost of caregiving		
	Cost of hiring professional caregivers	693,767	3.7
	Cost of informal caregiving	3,567,934	19.3
	Cost of transportation	970,087	5.2
	Cost of purchasing patient aids and devices	576,967	3.1
	Time costs		
	Patient's time costs	30,674	0.2
	Caregiver's time costs	213,965	1.2
	Direct non-medical costs	6,053,394	32.7
	Cost of long-term care	2,399,709	13.0
Indirect costs	Loss of patient's productivity	181,561	1.0
	Total	18,513,965	100.0

Source: MOHW (2011), Fact-Finding Survey on Dementia Patients

III

Distribution of Dementia Patients

III Distribution of Dementia Patients

This study examines the NHI cohort and elderly cohort data provided by the NHIS and compares them to other sources of information on the prevalence rate of dementia.

This study first estimates the prevalence rate of dementia in Korea using the elderly cohort data of the NHIS spanning the period from 2002 to 2013. Data pertaining to seniors aged 65 and older who had been diagnosed with the types of dementia eligible for the dementia care subsidies—i.e., dementia caused by Alzheimer's disease (F00), vascular dementia (F01), dementia caused by other diseases classified elsewhere (F02), unspecified dementia (F03), and Alzheimer's disease (G30)—were singled out. Next, the data on patients who had been hospitalized or received outpatient care for dementia as their main diagnosis or primary co-diagnosis were singled out from the NHI cohort data.

〈Table 3-1〉 Diagnostic Codes for Dementia, ICD-10

ICD-10	
F00	Dementia in Alzheimer's disease (G30.-+)
F01	Vascular dementia
F02	Dementia in other diseases classified elsewhere
F03	Unspecified dementia
G30	Alzheimer's disease

Note: These are the types of dementia eligible for the dementia care subsidies.

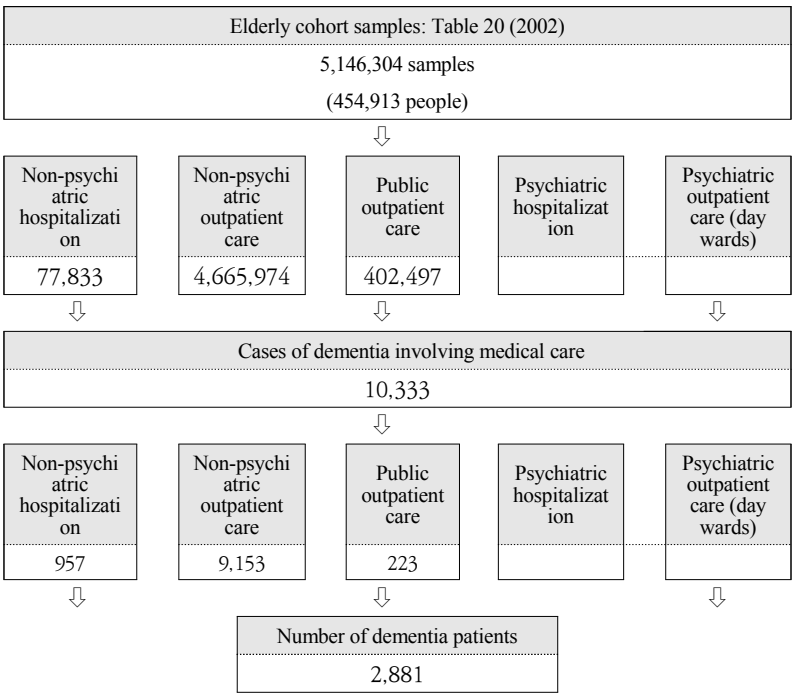
The data on patients who had been diagnosed with dementia or sought medical treatment for dementia, as indicated by the NHI cohort data, could vary significantly depending on when the onset of dementia occurred and whether patients have consistently received care or discontinued care. Some patients leave the care program for six months or even a year before resuming once again. It was thus necessary to identify and connect the data on patients who had discontinued their care so that they, too, would be counted among the affected population.

The elderly cohort data from 2002 include samples from around 550,000 seniors, accounting for approximately 10 percent of the elderly population aged 60 and older. Of these, 35.14 percent were aged 60 to 64; 10.97 percent, 75 to 79; and 3.69 percent, 85 and older. Also, 41.31 percent were male and 58.69 percent were female.

〈Table 3-2〉 Elderly Cohort Data Structure: 2002

		N	%
Gender	Male	230,582	41.31
	Female	327,565	58.69
Age	60 to 64	196,116	35.14
	65 to 69	147,361	26.40
	70 to 74	97,657	17.50
	75 to 79	61,217	10.97
	80 to 84	35,215	6.31
	85+	20,581	3.69
Total		558,147	100.00

[Figure 3-1] Analyzed Data Structure: 2002



Note: Number of cohort samples in 2002 = 558,147
Cohort samples of 2002 that received medical services = 454,913

The elderly cohort samples from 2002 included approximately 560,000 people, of whom 450,000 or so had received medical services in the same year. Specifically, 78,000 patients had been hospitalized and roughly 4,670,000 had received outpatient care. The number of instances of medical care provided for dementia was around 10,000, with 2,881 patients officially diagnosed with the condition.

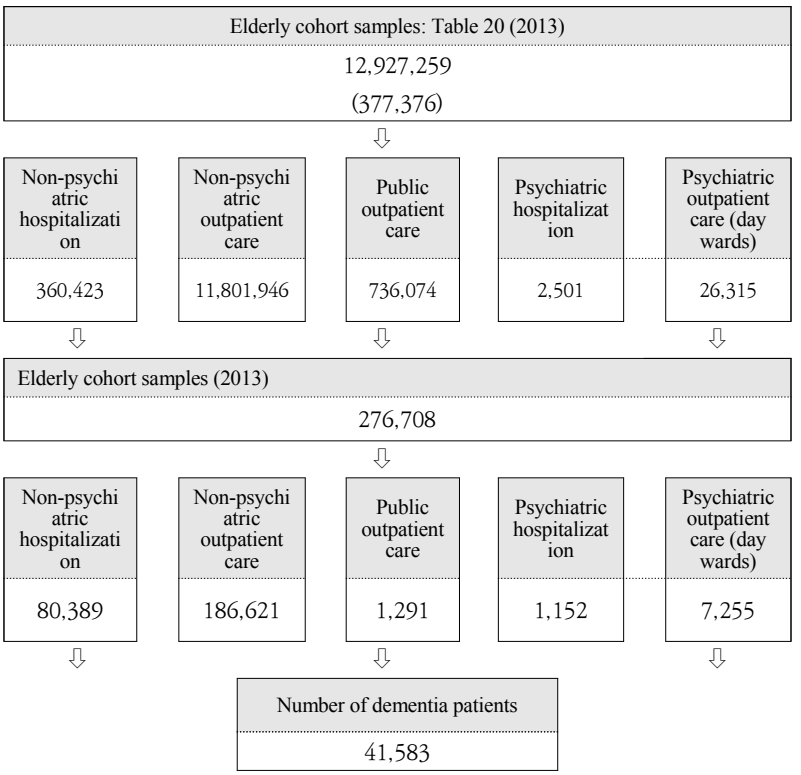
By 2013, the number of elderly cohort samples was reduced

to 390,000, with many seniors having died during the intervening years. The seniors who were 60 years old when they were first included in the cohort data in 2002 had aged to 71 years old, shifting the age structure of the elderly cohort upward to the 70s and older. Specifically, 36.17 percent were aged 70 to 74; 32.28 percent, 75 to 79; 18.53 percent, 80 to 84; and 12.92 percent, 85 and older. Also, 38.46 percent were male and 61.54 percent were female.

〈Table 3-3〉 Elderly Cohort Data Structure: 2013

		N	%
Gender	Male	149,422	38.46
	Female	239,071	61.54
Age	70 to 74	140,503	36.17
	75 to 79	125,795	32.38
	80 to 84	71,993	18.53
	85+	50,202	12.92
Total		388,493	100.00

[Figure 3-2] Analysis on Data Structure: 2013



Note: Number of cohort samples in 2013 = 388,493
Cohort samples of 2013 that received medical services = 377,376

In 2002, the prevalence rate of dementia among seniors aged 60 and older was 0.52 percent, while the rate among seniors aged 70 and older was 0.96 percent. Although these are strikingly low proportions, the prevalence rate of dementia among seniors aged 70 had jumped to 10.70 percent (about 388,000 patients) by 2013.

〈Table 3-4〉 Prevalence Rates of Dementia: 2002

Age	Non-dementia	Dementia	Total	%
60 to 64	195,802	314	196,116	0.16
65 to 69	146,857	504	147,361	0.34
70 to 74	96,989	668	97,657	0.68
75 to 79	60,593	624	61,217	1.02
80 to 84	34,715	500	35,215	1.42
85+	20,310	271	20,581	1.32
Total	555,266	2,881	558,147	0.52

〈Table 3-5〉 Prevalence Rates of Dementia: 2013

Age	Non-dementia	Dementia	Total	%
70 to 74	133,923	6,580	140,503	4.68
75 to 79	114,425	11,370	125,795	9.04
80 to 84	60,616	11,377	71,993	15.80
85+	37,946	12,256	50,202	24.41
Total	346,910	41,583	388,493	10.70

Before examining the types and distribution of the diseases of multimorbidity that dementia patients have in Korea, it is first necessary to define the concept and scope of multimorbidity. This study examines 46 chronic diseases of multimorbidity as classified by van den Bussche et al. (2011).[7] The authors used health insurance claim data in Germany to identify chronic diseases with prevalence rates of one percent or greater among German seniors aged 65 and older. They then consulted with experts and categorized the diseases so identi-

7) van den Bussche et al. Which chronic diseases and disease combinations are specific to multimorbidity in the elderly? Results of a claims data based cross-sectional study in Germany. BMC Public Health 2011;11:101.

fied using the ICD-10 diagnostic codes, resulting in a list that includes 46 diseases in total (Jeong et al., 2013). The authors categorize the diseases of dementia as those identified as F00 through F03, F05.1, G30, G31, and R54, according to the ICD-10 diagnostic codes.

〈Table 3-6〉 Categorization of Chronic Diseases

No.	Chronic disease	ICD-10 code
1	Hypertension	I10-I15
2	Lipid metabolism disorders	E78
3	Chronic low back pain	M40-M45, M47, M48.0-M48.2, M48.5-M48.9, M50-M54
4	Severe vision reduction	H17-H18, H25-H28, H31, H33, H34.1-H34.2, H34.8-H34.9, H35-H36, H40, H43, H47, H54
5	Osteoarthrosis	M15-M19
6	Diabetes mellitus	E10-E14
7	Chronic ischemic heart disease	I20, I21, I25
8	Thyroid dysfunction	E01-305, E06.1-E06.3, E06.5, E06.9, E07
9	Cardiac arrhythmias	I44-I45, I46.0, I46.9, I47-I48, I49.1-I49.9
10	Obesity*	E66
11	Purine/pyrimidine metabolism disorders/Gout	E79, M10
12	Prostatic hyperplasia	N40
13	Lower limb varicosis	I83, I87.2
14	Liver disease	K70, K71.3-K71.5, K71.7, K72.7, K73-K74, K76
15	Depression	F32-F33
16	Asthma/COPD	J40-J45, J47
17	Noninflammatory gynecological problems	N81, N84-N90, N93, N95
18	Atherosclerosis/PAOD	I65-I66, I67.2, I70, I73.9
19	Osteoporosis	M80-M82
20	Renal insufficiency	N18-N19
21	Cerebral ischemia/Chronic stroke	I60-I64, I69, G45

No.	Chronic disease	ICD-10 code
22	Cardiac insufficiency	I50
23	Severe hearing loss	H90, H91.0, H91.1, H91.3, H91.8, H91.9
24	Chronic cholecystitis/Gallstones	K80, K81.1
25	Somatoform disorders	F45
26	Hemorrhoids	I84
27	Intestinal diverticulosis	K57
28	Rheumatoid arthritis/Chronic polyarthritis	M05-M06, M79.0
29	Cardiac valve disorders	I34-I37
30	Neuropathies	G50-G64
31	Dizziness	H81-H82, R42
32	Dementia	F00-F03, F05.1, G30, G31, R54
33	Urinary incontinence	N39.3-N39.4, R32
34	Urinary tract calculi	N20
35	Anemia	D50-D53, D55-D58, D59.0-D59.2, D59.4-D59.9, D60.0, D60.8, D60.9, D61, D63-D65
36	Anxiety	F40-F41
37	Psoriasis	L40
38	Migraine/chronic headache	G43-G44
39	Parkinson's disease	G20-G22
40	Cancers	C00-C14, C15-C26, C30-C39, C40-C41, C43-C44, C45-C49, C50, C51-C58, C60-C63, C64-C68, C69-C72, C73-C75, C81-C96, C76-C80, C97, D00-D09, D37-D48
41	Allergies	H01.1, J30, L23, L27.2, L56.4, K52.2, K90.0, T78.1, T78.4, T88.7
42	Chronic gastritis/GERD	K21, K25.4-K25.9, K26.4-K26.9, K27.4-K27.9, K28.4-K28.9, K29.2-K29.9
43	Sexual dysfunction	F52, N48.4
44	Insomnia	G47, F51
45	Tobacco abuse	F17
46	Hypotension	I95

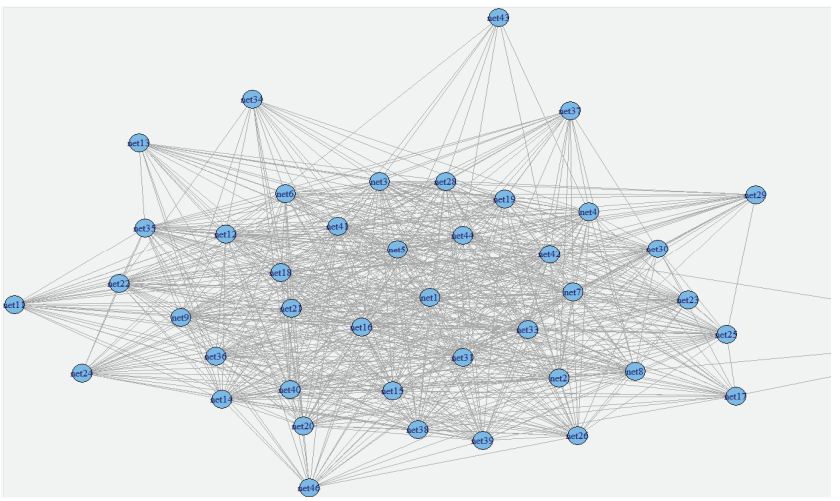
Note: ICD=International Classification of Diseases(10th edition)
Source: Jeong et al. (2013)

In order to quantify the network relations of the multimorbidity of dementia patients, this study analyzes the Pagerank-Index scores on the number of connections shown on the graph.

The Pagerank-Index counts how many pages cite other certain pages, thus providing a measure of how influential those pages are. By normalizing the number of links posted on any given page, the sum of the Pagerank-Index scores becomes one.

As the focus of this study is to identify the common diseases of multimorbidity, among the 46 listed above, in dementia patients, diseases categorized as dementia were excluded. Furthermore, tobacco abuse, which is not included in the NHI codes for covered diseases, and obesity, for which the NHI policy is rarely used, were also excluded.

[Figure 3-3] Multimorbidity Network of Dementia Patients



The Pagerank-Index analysis on the multimorbidity of dementia patients reveals hypertension to be the most common comorbidity in dementia patients, located at the center of the network, as shown in Figure 3-5.

〈Table 3-7〉 Pagerank-Index Analysis on the Multimorbidity of Dementia Patients

No.	Chronic disease	Score	No.	Chronic disease	Score
1	Hypertension	0.09102	24	Chronic cholecystitis/gallstones	0.00604
2	Lipid metabolism disorders	0.03281	25	Somatoform disorders	0.00689
3	Chronic lower back pain	0.06002	26	Hemorrhoids	0.00729
4	Severe vision loss	0.03289	27	Intestinal diverticulosis	0.00361
5	Osteoarthrosis	0.04708	28	Rheumatoid arthritis/chronic polyarthritis	0.02889
6	Diabetes mellitus	0.04361	29	Cardiac valve disorders	0.00458
7	Chronic ischemic heart disease	0.02598	30	Neuropathies	0.01313
8	Thyroid dysfunction	0.01234	31	Dizziness	0.02839
9	Cardiac arrhythmias	0.01211	32	Dementia*	-
10	Obesity*	-	33	Urinary incontinence	0.01788
11	Purine/pyrimidine metabolism disorders/Gout	0.00493	34	Urinary tract calculi	0.00414
12	Prostatic hyperplasia	0.01801	35	Anemia	0.01571
13	Lower limb varicosis	0.00492	36	Anxiety	0.02686
14	Liver diseases	0.01327	37	Psoriasis	0.00465
15	Depression	0.03854	38	Migraine/chronic headache	0.01433

No.	Chronic disease	Score	No.	Chronic disease	Score
16	Asthma/COPD	0.03718	39	Parkinson's disease	0.01649
17	Noninflammatory gynecological problems	0.00665	40	Cancers	0.01351
18	Atherosclerosis/PAOD	0.03283	41	Allergies	0.04747
19	Osteoporosis	0.02822	42	Chronic gastritis/GERD	0.08443
20	Renal insufficiency	0.00902	43	Sexual dysfunction	0.00371
21	Cerebral ischemia /chronic stroke	0.04307	44	Insomnia	0.03325
22	Cardiac insufficiency	0.01197	45	Tobacco abuse*	-
23	Severe hearing loss	0.00788	46	Hypotension	0.00439

Note: Obesity and tobacco abuse were excluded from the analysis.

Hypertension emerged as the most common comorbidity in dementia patients, followed by gastritis, chronic lower back pain, allergies, osteoarthrosis, diabetes, stroke, depression, asthma, and insomnia, in descending order.

〈Table 3-8〉 Ranking of Comorbidities in Dementia Patients by Prevalence

Rank	No.	Comorbidity	Score	Rank	No.	Comorbidity	Score
1	1	Hypertension	0.09102	23	38	Migraine/chronic headache	0.01433
2	42	Chronic gastritis/GERD	0.08443	24	40	Cancers	0.01351
3	3	Chronic lower back pain	0.06002	25	14	Liver diseases	0.01327
4	41	Allergies	0.04747	26	30	Neuropathies	0.01313
5	5	Osteoarthrosis	0.04708	27	8	Thyroid dysfunction	0.01234
6	6	Diabetes	0.04361	28	9	Cardiac arrhythmias	0.01211
7	21	Cerebral	0.04307	29	22	Cardiac	0.01197

Rank	No.	Comorbidity	Score	Rank	No.	Comorbidity	Score
		ischemia/ chronic stroke				insufficiency	
8	15	Depression	0.03854	30	20	Renal insufficiency	0.00902
9	16	Asthma/COPD	0.03718	31	23	Severe hearing loss	0.00788
10	44	Insomnia	0.03325	32	26	Hemorrhoids	0.00729
11	4	Severe vision reduction	0.03289	33	25	Somatoform disorders	0.00689
12	18	Atherosclerosis/ PAOD	0.03283	34	17	Noninflammatory gynecological problems	0.00665
13	2	Lipid metabolism disorders	0.03281	35	24	Chronic cholecystitis/ allstones	0.00604
14	28	Rheumatoid arthritis /chronic polyarthritis	0.02889	36	11	Purine/pyrimidine metabolism disorders/gout	0.00493
15	31	Dizziness	0.02839	37	13	Lower limb varicosis	0.00492
16	19	Osteoporosis	0.02822	38	37	Psoriasis	0.00465
17	36	Anxiety	0.02686	39	29	Cardiac valve disorders	0.00458
18	7	Chronic ischemic heart disease	0.02598	40	46	Hypotension	0.00439
19	12	Prostate hyperplasia	0.01801	41	34	Urinary tract calculi	0.00414
20	33	Urinary incontinence	0.01788	42	43	Sexual dysfunction	0.00371
21	39	Parkinson's disease	0.01649	43	27	Intestinal diverticulosis	0.00361
22	35	Anemia	0.01571				

IV Estimating the Lifetime Cost of Dementia

A. Model Framework

B. Transition Matrix of LTCIS Eligibility Grades

C. Mortality Estimates

D. Unit Medical Cost Estimates

E. Cohort Transition Process

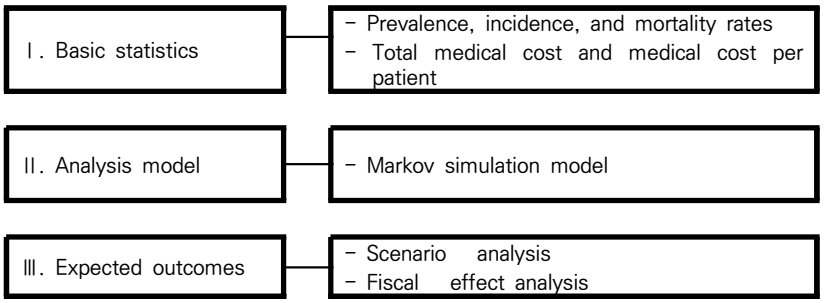
IV Estimating the Lifetime Cost of Dementia

As of 2010, the economic cost of dementia per patient in Korea was KRW 18.51 million, while the total social cost of caregiving was KRW 8.7 trillion. Of seniors eligible for the Long-Term Care Insurance for Seniors (LTCIS) services, 30.23 percent were diagnosed with dementia, and 6.74 percent were diagnosed with both dementia and stroke.[8] In other words, almost 37 percent of LTCIS-eligible seniors are suffering from dementia.

To pave the way for more effective policymaking on dementia prevention and management in the future, we need to estimate and analyze the lifetime medical cost of dementia for patients and the financial burden on their families. This study thus estimates the lifetime medical cost of dementia per patient, taking into account patients' gender, age, and health status, and performs Markov simulations to see how effective prevention and management of the disease would affect the country's fiscal resources in the intermediate to long term.

8) NHIS (2015), Statistics on the LTCIS.

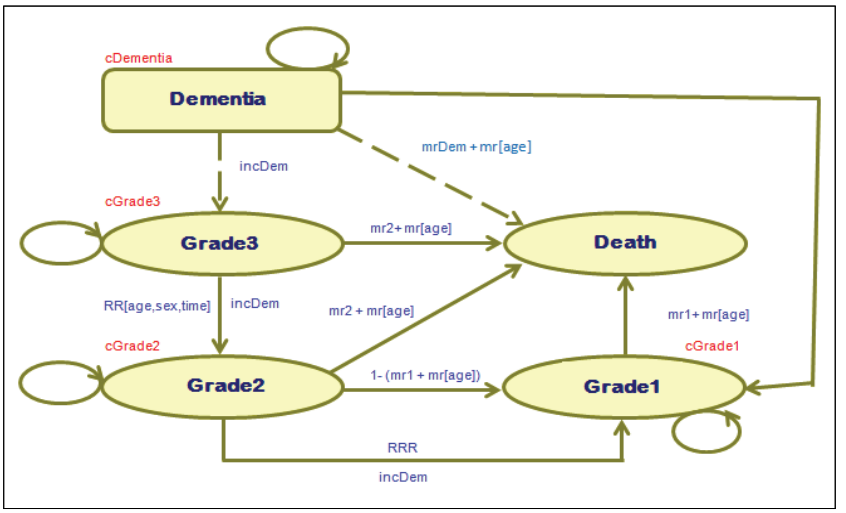
[Figure 4-1] Markov Model Simulation



A. Model Framework

The Markov cohort simulations were performed to analyze the social cost of caring for dementia patients. The Markov model involves applying either a deterministic decision-making model or a probabilistic decision-making model such as the Monte Carlo simulation. As shown in Figure 4-2, the Markov model used in this study identifies the paths along which movements take place into the Markov state according to the given transition probabilities by each Markov cycle, so that the number of patients and amount of costs can be estimated for each given state. The endpoint of the Markov process is the absorbing state, or patients' death. The Markov states used in the simulations were the LTCIS Eligibility Grades 1 through 3, other stages of dementia, and death. These states move in a cyclical direction, transitioning along the paths indicated by the arrows.

[Figure 4-2] Baseline Model



To estimate the prevalence and incidence rates of dementia in Korea, the elderly cohort data were analyzed. In 2013, of the 43,295 seniors diagnosed with dementia, 40.13 percent applied for the LTCIS. Of these, 3.10 percent were in LTCIS Grade 1; 6.68 percent, in Grade 2; and 22.55 percent, in Grade 3.

〈Table 4-1〉 Distribution of LTCIS Eligibility Grades among Dementia Patients

(Units: %, number of people)

Age	Grade 1	Grade 2	Grade 3	Grade 5 and other	LTCIS applicants	Total number of patients
2012						
70 to 74	2.36	4.26	14.13	6.06	26.81	7,494
75 to 79	2.76	5.74	17.39	8.56	34.45	10,503
80 to 84	3.51	7.52	21.63	9.83	42.49	10,263
85+	4.14	10.03	26.45	8.15	48.77	10,923
Total	3.26	7.12	20.40	8.30	39.09	39,183

Age	Grade 1	Grade 2	Grade 3	Grade 5 and other	LTCIS applicants	Total number of patients
2013						
70 to 74	2.55	4.09	15.11	5.74	27.49	6,776
75 to 79	2.56	5.34	19.79	7.70	35.39	11,789
80 to 84	3.13	6.62	24.23	9.23	43.20	11,921
85+	3.85	9.35	27.46	7.67	48.33	12,809
Total	3.10	6.68	22.55	7.81	40.13	43,295

Source: NHIS' elderly cohort database

B. Transition Matrix of LTCIS Eligibility Grades

The health of dementia patients can change throughout the remaining course of their lives. These transition probabilities are estimated using a Markov chain model, assuming that the probabilities remain constant over time (Jeong et al., 2009).

This study sets up four Markov states of patients, i.e., LTCIS Grades 1 through 3 and other grades. Table 4-2 shows the transition matrix, which lists the probabilities of patients in one state moving into another state from the previous year (t) to the given year (t+1).

〈Table 4-2〉 Definitions of the Markov States and the Transition Matrix: LTCIS Applicants

		Cycle t+1				
	Cycle t	tpMa	tpMb	tpMc	tpMd	Death (D)
Grade 1	tpMa	1.0000				tpMa+mr
Grade 2	tpMb	0.1704	0.8296			tpAb+mr
Grade 3	tpMc	0.0457	0.1321	0.8222		tpMc+mr
Other grades	tpMd	0.0317	0.0898	0.6041	0.2743	tpMd+mr

Source: NHIS' elderly cohort database

The transition probabilities of dementia patients when the patients that have not applied for the LTCIS care are included are listed in Table 4-3. After being diagnosed with dementia, patients can proceed from the state of non-eligibility (other grades) to Grade 3, Grade 2, and Grade 1, and ultimately death. Some patients skip all preceding states and enter Grade 1 immediately after their diagnosis. This model assumes that there are no exceptional cases, i.e., patients moving from Grade 1 back to Grade 3, and changes the applying probabilities according to age.

〈Table 4-3〉 Transitions among the LTCIS Eligibility Grades of Dementia Patients

		Cycle t+1				
	Cycle t	tpMa	tpMb	tpMc	tpMd	Death (D)
Grade 1	tpMa	1.0000				tpMa+mr
Grade 2	tpMb	0.1986	0.8014			tpAb+mr
Grade 3	tpMc	0.0452	0.1308	0.8240		tpMc+mr
Other grades	tpMd	0.0044	0.0124	0.0836	0.8995	tpMd+mr

C. Mortality Estimates

The available sources of data necessary for estimating the mortality rates of dementia patients in Korea by age include the raw data used for Statistics Korea's analysis on the causes of mortality and the NHIS' elderly cohort database, which includes Statistics Korea's raw data on the causes of mortality.

Statistics Korea's raw data on the causes of mortality are most commonly used to estimate the mortality rates in Korea. Statistics Korea divides the number of people who die every year due to a given cause by the size of the mid-year population, and multiplies the result by 100,000 to indicate the rate and number of deaths associated with each given cause (KOSIS).

$$Mortality\,rate\,of\,a\,given\,cause = \frac{Nmber\,of\,deaths}{Mid-year\,population} \times 100{,}000$$

In the case of dementia patients, however, dementia is rarely the direct cause of their death. It is thus necessary to estimate the mortality rates of dementia patients from diverse co-morbidities by applying the direct adjustment method.

〈Table 4-4〉 Mortality Rates of Dementia Patients by LTCIS Grade: 2013

	Grade 1	Grade 2	Grade 3	Grade 5 and other	All patients	Total (KOSIS)
70 to 74	0.19075	0.07220	0.05371	0.04413	0.05047	0.01857
75 to 79	0.22185	0.13672	0.06558	0.06804	0.07515	0.03373
80 to 84	0.22252	0.12801	0.06579	0.10507	0.10075	0.06020
85+	0.27992	0.18280	0.09383	0.18669	0.16442	0.13372

Source: NHIS' elderly cohort database

D. Unit Medical Cost Estimates

The cost of providing care for dementia patients under the LTCIS differs by the type of service or benefit provided. The monthly ceilings on at-home care available for patients in different LTCIS grades are listed below.

〈Table 4-5〉 Monthly Ceilings on Amounts of At-Home Care (January 2016)

LTCIS	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
KRW	1,196,900	1,054,300	981,100	921,700	784,100

The LTCIS also provides care via professional care facilities (geriatric care facilities and group homes) that either cater to all eligible seniors or specialize in the care of dementia patients.

〈Table 4-6〉 Daily Amounts of Care at Care Facilities (July 2016)

Facility type		General	Dementia-specialized	
			Type A	Type B
Geriatric care facilities	Grade 1	57,040	n/a	n/a
	Grade 2	52,930	65,280	58,750
	Grades 3 to 5	48,810	60,190	54,170
Group homes	Grade 1	51,290	n/a	
	Grade 2	47,590	59,000	
	Grade 3 to 5	43,870	54,390	

Patients who receive at-home care under the LTCIS are required to pay 15 percent of the cost, while patients at professional care facilities pay 20 percent of the cost of care

(Article 40, Act on Long-Term Care Insurance for Seniors). Patients under the National Basic Livelihood Security Program (NBLSP) are not required to make any co-payments. Other patients under the government's Medicare program pay only 50 percent of the standard co-payment rates. Under the LTCIS, all patients are responsible for paying for the meals, room upgrades, and hairdressing and grooming care they receive.

The majority of dementia patients are denied LTCIS care because their symptoms remain mild. Patients receiving LTCIS care require services from medical institutions in addition to the care they receive at home or care facilities. To analyze the costs of dementia borne by the NHI and LTCIS, it was thus necessary to analyze the elderly cohort data.

Table 4-7 shows the annual medical costs of dementia patients by LTCIS grade and insurance type (NHI or LTCIS). In 2013, each patient aged 70 to 74 in LTCIS Grade 1 received, on average, KRW 9.61 million in NHI benefits, KRW 5.58 million in LTCIS benefits in the form of facility care, and KRW 1.91 million in LTCIS benefits in the form of at-home care, for a total of KRW 17.1 million, of which each patient paid KRW 3.43 million in co-payments.

Each patient aged 70 to 74 in LTCIS Grade 3 received, on average, KRW 4.96 million in NHI benefits, KRW 2.45 million in LTCIS benefits in the form of facility care, and KRW 3.11 million in LTCIS benefits in the form of at-home care, for a total

of KRW 10.52 million, of which each patient paid KRW 1.97 million in co-payments. The co-payment rate for all medical services covered by the NHI and LTCIS was 15.8 percent.

Each patient aged 70 to 74 not eligible for LTCIS care paid, on average, 18.4 percent of the total cost of KRW 6.22 million a year in co-payments. The co-payment rate rose to 18.5 percent for patients aged 75 to 79 and 19.3 percent for patients aged 85 and older not eligible for LTCIS care.

〈Table 4-7〉 Annual Medical Benefits for Dementia Patients by LTCIS Grade: 2013

(Units: thousands of KRW, per patient)

	NHI-covered	Co-payment required by NHI	LTCIS-covered (facility care)	Co-payment required by LTCIS	LTCIS-covered (at-home care)	Co-payment required by LTCIS	Total
Grade 1							
70 to 74	9,607	2,216	5,580	946	1,907	267	20,523
75 to 79	8,822	2,115	4,816	787	2,159	321	19,020
80 to 84	9,944	2,372	5,047	890	1,764	252	20,268
85+	6,367	1,690	6,706	1,076	1,486	211	17,537
Grade 2							
70 to 74	8,306	1,860	4,525	830	2,260	317	18,098
75 to 79	6,882	1,778	5,306	884	1,844	250	16,944
80 to 84	6,481	1,633	5,583	872	1,979	273	16,822
85+	4,790	1,308	6,532	1,079	1,448	207	15,364
Grade 3							
70 to 74	4,957	1,132	2,452	413	3,111	422	12,487
75 to 79	4,399	1,110	2,577	425	2,914	392	11,817
80 to 84	3,976	995	2,971	480	2,762	372	11,555
85+	3,235	879	3,586	555	2,568	340	11,163
Other							
70 to 74	4,531	1,061	317	50	227	31	6,216
75 to 79	4,920	1,171	405	60	221	28	6,805
80 to 84	5,982	1,451	625	96	327	42	8,523
85+	7,219	1,889	1,224	176	457	60	11,026

E. Cohort Transition Process

This study estimated the transition probabilities of dementia patients using the dementia prevalence, incidence, and mortality rates. The changes in the prevalence rate were measured by adding the size of the existing affected population and the size of the newly affected population in each given year, and subtracting from the result the size of the existing affected population that had moved to another state and size of the deceased population in the same year. See the equation below.

$$PREV_{t+1} = PREV_t + TP_t + CON_t - MORT_t \qquad \text{Equation (1)}$$

Where:

$PREV_t$: number of patients remaining at end of term t.

TP_t : number of incident patients during term t.

$MORT_t$: number of patients who died during term t.

CON_t: number of patients who remained in the same state during term t.

The first Markov simulation was run on the first base case, i.e., dementia patients at age 70 who were denied LTCIS care because they were not recognized as belonging to any of Grades 1 to 3. The second simulation was run on the second base case, i.e., 1,000 dementia patients drawn randomly from the patient population irrespective of their LTCIS status. These simulations were run to estimate how the cohorts would change during the following decade.

Of the 1,000 patients aged 70 years old in the first base case

who were denied LTCIS care upon application, 178 are likely to enter Grade 1, 209 to enter Grade 2, and 296 to enter Grade 3 five years later, when they turn 75 years old. The remaining 317 patients are also likely to die by age 75.

Of the 1,000 patients aged 70 years old in the second base case who were selected irrespective of their LTCIS status, 283 are likely to enter Grade 1, 101 to enter Grade 2, and 360 to die in 10 years.

〈Table 4-8〉 Changes in Dementia Patient Cohorts Over the Next 10 Years

(Unit: number of people)

After	Age	Grade 1	Grade 2	Grade 3	Other	Deceased	Total
[Base case 1: LTCIS applicants who were denied care]							
3 years	73	119.4	212.1	495.7	12.2	160.7	1000.0
5 years	75	177.8	209.0	295.5	0.6	317.2	1000.0
10 years	80	153.9	88.5	73.4	0.0	684.3	1000.0
[Base case 2: All dementia patients]							
3 years	73	118.2	120.8	232.4	449.2	79.4	1000.0
5 years	75	181.6	131.5	205.5	333.5	148.0	1000.0
10 years	80	282.6	100.6	114.2	142.7	360.0	1000.0

The medical cost per patient for the first cohort or base case of patients over the next 10 years is expected to amount to KRW 80 million covered by the NHI and KRW 16 million in the form of co-payments. These figures, however, do not reflect the costs of services not covered by the NHI. Including these non-covered services would therefore increase the cost further.[9].

9) The rate of co-payments for care at geriatric hospitals not covered by the

The medical cost per patient for the second cohort or base case over the next 10 years is expected to be KRW 136.83 million covered by the NHI and KRW 21.92 million in the form of co-payments.

The reason the cost estimates are higher for the second base case is because the cohort includes all dementia patients irrespective of their LTCIS status. The pace at which these patients are projected to reach the state of death is slower than that of the first base case, with the increasing life expectancy naturally raising the cost estimates.

〈Table 4-9〉 Lifetime Medical Cost Per Patient among Dementia Patients who Applied for the LTCIS

(Unit: thousands of KRW)

After	Age	NHI-covered	Co-payments	Total
[Base case 1: LTCIS applicants who were denied care]				
3 years	73	30,395	5,879	36,273
5 years	75	49,252	9,614	58,866
10 years	80	79,476	15,750	95,226
[Base case 2: All dementia patients]				
3 years	73	31,844	6,151	37,994
5 years	75	55,628	10,688	66,316
10 years	80	114,917	21,915	136,832

Another simulation was run on 80-year-old dementia patients who were denied LTCIS care upon application to predict the changes in their lifetime medical costs over the next 10

NHI was 6.8 percent (NHIS, 2014, Fact-Finding Survey on the Medical Costs of NHI Patients).

years. Of the 1,000 such patients, 147 are likely to enter Grade 1, 167 to enter Grade 2, 245 to enter Grade 3, and 440 to die over the next five years.

When the cohort is changed to randomly draw 1,000 dementia patients irrespective of their LTCIS status, 123 are likely to enter Grade 1 and 746 to die over the next 10 years.

〈Table 4-10〉 Changes in Dementia Patient Cohorts Over the Next 10 Years: 80-Year-Olds

(Unit: number of people)

	Age	Grade 1	Grade 2	Grade 3	Other	Deceased	Total
[Base case 1: LTCIS applicants who were denied care]							
3 years	83	110.1	187.3	440.3	4.9	257.4	1000.0
5 years	85	147.0	167.4	245.2	0.1	440.4	1000.0
10 years	90	94.0	55.4	50.3	0.0	800.3	1000.0
[Base case 2: All dementia patients]							
3 years	83	104.2	103.5	194.6	367.9	229.8	1000.0
5 years	85	138.5	95.4	144.4	227.6	394.0	1000.0
10 years	90	123.0	38.8	42.0	50.5	745.8	1000.0

The average medical cost per patient for the first cohort is expected to amount to KRW 50 million over the next five years and KRW 70 million over the next 10 years.

〈Table 4-11〉 Lifetime Medical Cost Per Patient among 80-Year-Old Dementia Patients

(Unit: thousands of KRW)

	Age	NHI-covered	Co-payments	Total
[Base case 1: LTCIS applicants who were denied care]				
3 years	83	26,683	5,247	31,930
5 years	85	41,508	8,188	49,696
10 years	90	61,344	12,160	73,504
[Base case 2: All dementia patients]				
3 years	83	46,718	8,974	55,692
5 years	85	28,547	5,511	34,058
10 years	90	78,648	15,017	93,664

Dementia is a major social issue because it radically undermines the quality of life and financial security of not only the patients but also their loved ones. By estimating the financial burden that dementia imposes upon patients and their families, we could estimate the long-term sustainability of the NHI resources and improve future fiscal policymaking. Much of the existing literature on this topic, however, analyzes the fiscal burdens of dementia for only short periods of time, up to one year. Although these studies may provide pertinent information for policymakers struggling to make decisions regarding support measures for dementia patients and families in the current year, estimating the lifetime financial burden of dementia, on the other hand, is crucial to assessing the cost-effectiveness of dementia prevention programs and alternative treatments (Jeong et al., 2009). Because the NHI and LTCIS cover significant portions of the costs of sustained care for dementia

patients in Korea, such long-term estimates and assessments are all the more important.

This study thus ran Markov simulations on dementia patients receiving care under the LTCIS, on the one hand, and simulations on the remaining dementia patients by age and gender. However, there are important shortcomings of this study that must be taken into account in order to improve the research process and results on related topics in the future.

First, to determine the distribution of morbidities among Koreans, it is important to secure pathological, time-series data on the incidence, prevalence, and mortality rates of diseases as well as on the severity of disabilities and the functional impairments they cause. For such data, this study relies on the NHIS' elderly cohort database. However, there are studies that cite the same database yet differ widely in their estimates of prevalence and incidence rates. Data have their own characteristics that can significantly affect the results of long-term analyses. In future studies, it will be necessary to also analyze long-term NHI billing data in order to trace and estimate the incidence and prevalence rates and transition probabilities of dementia with greater accuracy. As the NHI billing data do not provide all necessary information, additional research needs to be conducted to generate more pathological information. Increasing the amount of available information in such ways is the only way to help us make better policy decisions, as it en-

ables us to better project the expected outcomes.

Second, there are two main types of Markov simulation models: deterministic cohort simulation models and stochastic simulation models. This study uses a model of the former type. Deterministic models are used to test hypotheses under a number of different scenarios (e.g., typical scenario vs. extreme-case scenario) and/or when there are few changes in the values of the variables used. Stochastic models, on the other hand, are used in a wide range of areas involving healthcare, such as simulations of demand for healthcare personnel, physician behavior, medical technology assessments, and health insurance policy programs (Jeong et al., 2009). Unlike the stochastic model, the deterministic model used in this study is unable to capture and reflect the uncertainty of all the variables used. In future studies, researchers will thus have to set up stochastic simulation models and relax the hypotheses used in this study in order to account for the uncertainty inherent to our projections.

V

Expected Effects of Dementia Prevention Efforts

V Expected Effects of Dementia Prevention Efforts

A number of factors are involved in preventing dementia, including developmental, socio-psychological (mental health), health-behavioral, and cardiovascular risk factors. Intervention toward mitigating these factors can thus help reduce the risks of dementia among the elderly.

Hypertension, diabetes, dyslipidemia, obesity, and smoking are preceding factors that increase the risks of cardiovascular diseases. Patients who have suffered strokes are also known to be twice as likely than others to experience dementia later in life (Savva and Stephan, 2010).[10]

Norton et al. (2014) identifies seven major risk factors of dementia: obesity and hypertension in people under the age of 65, physical inactivity, smoking, diabetes, and depression. The definition of each is provided in Table 5-1.

The definitions of the dementia risk factors used in this study, which are based upon the variables used in the National Health and Nutrition Surveys, are listed in the right column of the same table.

10) Savva, G. & Stephan, B. (2010), Epidemiological studies of the effect of stroke on incident dementia: a systematic review, Stroke 41.

〈Table 5-1〉 Risk Factors of Dementia

Risk factor	Norton et al. (2014)	This study
Education	Proportion of adults at educational level 2 or below according to the International Standard Classification of Education (lower secondary education)	Proportion of adults with middle-school education or below
Obesity under age 65	Prevalence rate of obesity (BMI 30 or greater) among adults aged 35 to 64	Prevalence rate of obesity (BMI 30 or greater) among adults aged 25 to 64
Hypertension under age 65	Prevalence rate of hypertension among adults aged 35 to 64	Prevalence rate of hypertension among adults aged 35 to 64
Physical inactivity	Proportion of adults who do not engage in rigorous exercise for 20 minutes or longer three days a week or medium-intensity exercise for 30 minutes or longer five days a week	Proportion of adults who do not engage in medium-intensity exercise for 2.5 hours or longer or high-intensity exercise for 1.25 hours or longer a week
Smoking	Adult smoking rate	Current adult smoking rate
Diabetes	Prevalence rate of diabetes among adults aged 20 to 79	Current prevalence rate of diabetes among adults aged 20 and older
Depression	Lifetime prevalence rate based on major symptoms of depression	Proportion of adults scoring 10 out of 27 or higher on PHQ-9 tests

In order to estimate the extent to which these risk factors contribute to the prevalence of dementia, it is necessary to determine the relative risk of each factor. This study estimates the relative risks of the seven factors on the basis of Barnes and Yaffe (2011),[11] and its update provided in Norton et al. (2014).

11) BARNES, D. E. & YAFFE, K. Y. 2011. The Projected effect of risk factor reduction on Alzheimer's disease prevalence. The Lancet Neurology, 10, 819-828.

Norton et al. (2014) estimates the relative risks of the seven factors based on a systematic review and meta-analysis of the existing literature on strategies for preventing dementia.

〈Table 5-2〉 Relative Risks of Dementia Risk Factors

Risk factor	Relative risk	(95% CI)
Education	1.59	1.35~1.86
Obesity under age 65	1.6	1.34~1.92
Hypertension under age 65	1.61	1.16~2.24
Physical inactivity	1.82	1.19~2.78
Smoking	1.59	1.15~2.20
Diabetes	1.46	1.20~1.77
Depression	1.65	1.42~1.92

The equation below is applied to the relative risks of the risk factors and the prevalence rates of dementia so estimated to estimate the population attributable risk (PAR) of each factor.

$$PAR = [P_{RF} x \frac{RR-1}{1+P_{RF^*}[RR-1]}]$$

Where, P_{RF}=prevalence rate of each risk factor among the given population;
RR=relative risk of each risk factor.

Assuming the independence of the risk factors, the extent to which the combination of these risk factors contributes to raising the prevalence rate of dementia can be estimated as follows:

$$PAR_{combined} = 1 - \Pi 1 - PAR$$

The PAR, however, represents the influence of individual (not combined) risk factors on dementia. It is thus necessary to first analyze the communality of the risk factors. For this, a principal component analysis (PCA) was performed on the basis of the National Health and Nutrition Surveys. This method, recommended by Norton et al. (2014), involves applying the equation shown below to risk factors that could potentially share commonalities and are not clearly independent, with the goal of estimating the overall adjusted combined PAR () by estimating the ratio according to which the commonalities are distributed across the risk factors. In other words, this method involves using the weights of the commonalities among the risk factors.

$$PAR_{AdjustedCombined} = 1 - \Pi 1 - (w \times PAR)$$

〈Table 5-3〉 Communality of Risk Factors

Risk Factor	Relative risk	Communality (%)	Prevalence rate* (%)
Education	1.59	29.54	25.57
Obesity under age 65	1.60	8.74	33.12
Hypertension under age 65	1.61	54.39	11.10
Physical inactivity	1.82	25.52	49.20
Smoking	1.59	34.75	21.57
Diabetes	1.46	12.04	5.49
Depression	1.65	1.18	5.88

Note: Based on the raw data used for the National Health and Nutrition Survey (2014)

Because each individual could carry two or more of these risk factors simultaneously, it is important to readjust the dispersion of the risk factors. The adjusted combined PAR of the seven risk factors thus amounts to 18.02 percent.

Assuming there are 450,000 dementia patients in Korea, obesity among adults under the age of 65 would be responsible for the dementia in 70,000 of these patients; physical inactivity, for 130,000; and the combination of all seven risk factors, for 260,000. Because each patient is likely to have at least two or more combined risk factors, we could end up overestimating the influence of these factors on dementia if we fail to consider the dispersion of communality. By adjusting our estimates to account for this, we could conclude that the combination of the seven risk factors is responsible for dementia in roughly 80,000 patients in Korea.

〈Table 5-4〉 Number of Dementia Patients Influenced by the Risk Factors

Risk Factor	Prevalence rate (%)	PAR (%)	Out of 450,000 patients
Education	25.57	13.11	58,990
Obesity under age 65	31.45	15.87	71,431
Hypertension under age 65	8.01	4.66	20,975
Physical inactivity	49.20	28.74	129,351
Smoking	21.57	11.29	50,806
Diabetes	5.49	2.46	11,092
Depression	5.88	3.68	16,576
Combined	n/a	59.69	263,774
Adjusted Combined	n/a	18.02	81,108

Table 5-5 lists the number of dementia patients there would be if the influences of the seven risk factors were reduced by 10 percent each through public health and intervention programs. Such intervention efforts would free 6,329 patients from the risk of dementia.

〈Table 5-5〉 Reducing Risk Factors' Contributions to Prevalence Rates by 10%

Risk Factor	Prevalence rate (%)	PAR (%)	Patients freed from dementia
Education	23.01	11.95	5,194
Obesity under age 65	28.30	14.52	6,106
Hypertension under age 65	7.21	4.21	2,009
Physical inactivity	44.28	26.64	9,490
Smoking	19.41	10.28	4,558
Diabetes	4.94	2.22	1,085
Depression	5.30	3.33	1,602
Combined		59.69	15,621
Adjusted Combined		16.62	6,329

VI Conclusion

VI Conclusion

Dementia is one of the highest-priority healthcare issues not only in Korea but around the world as well. The prevalence rates of dementia differ from source to source. This study estimates the prevalence rate of dementia among seniors aged 65 and older in Korea to be 7.47 percent (about 460,000 patients) based on the NHI cohort data. The estimated rate increases to 9.98 percent (about 420,000 patients) among seniors aged 70 and older. As the aging of the Korean population is progressing rapidly, the number and proportion of dementia patients are expected to increase as well, as are the social and economic costs of treating and caring for these patients. The prevalence rate of dementia among seniors aged 65 and older is indeed projected to increase from 9.79 percent in 2015 to 10.03 percent in 2030 and even further to 15.06 percent in 2050.

Hypertension is the most common comorbidity in Korean dementia patients today, followed by gastritis, chronic low back pain, allergies, osteoarthrosis, diabetes, stroke, depression, asthma, and insomnia, in descending order. There are relatively high proportions of dementia patients suffering from depression or insomnia or both, indicating the need for effective policy strategies to improve the overall health and quality of life of these patients.

The medical cost per capita for patients aged 70 and older over the next 10 years is expected to amount to KRW 80 million covered by the NHI and KRW 16 million in the form of co-payments. These figures do not include the costs of services and care not covered by the NHI or LTCIS. Including the costs of such non-covered services would increase the medical costs even more dramatically.

This study finds that public health and intervention programs geared toward reducing the major risk factors of dementia, such as hypertension, physical inactivity, smoking, diabetes, and depression, would reduce the number of dementia patients by almost 18 percent, from the current 450,000 or so. Reducing the influence of these major risk factors on the prevalence rate of dementia would free 6,329 seniors from the risk of dementia.

The prevention of dementia calls for public healthcare strategies for the following:

- Enhancing the effectiveness of primary prevention efforts;
- Strengthening health management approaches that are based on communities and target the entire population;
- Strengthening the role of empirical evidence; and
- Reducing the inequality of care concerning dementia.

Policymakers have already introduced diverse policy measures and programs designed to reduce the risk factors of dementia, including anti-smoking clinics and cardiovascular disease prevention programs. Nevertheless, these programs and

strategies still remain outside and separate from the public health policies that aim to enhance brain health in general.

Numerous studies addressing the diverse issues of dementia have been published, but no definitive evidence has been produced to support effective policy intervention strategies. It is thus critical for policymakers and researchers to secure the pathological and empirical evidence necessary for effective intervention, and use the evidence to define the goals and indicators of public healthcare programs.

To reduce the risk factors of dementia in the entire population, it is also important to understand and target the broad range of health factors that affect dementia and expand policy resources for reducing risk factors that compromise social health, including, among others, educational attainment, health behavior, and cardiovascular diseases.

Policy efforts and resources should also be invested in ensuring that no class differences exist in reducing the preventable risk factors of dementia. Greater efforts are also needed to raise awareness among middle-aged people regarding brain health and the importance of taking measures to prevent dementia throughout their lifetimes. This requires the development of a holistic and comprehensive strategy for reducing and managing the risk factors of dementia in all stages of citizens' lives.

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