Home Care Service Utilization in Universal Long-term Care Insurance and Risk of Dementia Progression and Other Health Outcomes in Older Adults with Dementia

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Home Care Services in Universal Long-term Care Insurance and Risk of Dementia Progression and Other Health Outcomes in Older Adults with Dementia

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ABSTRACT

Home Care Services in Universal Long-term Care Insurance and Risk of Dementia Progression and Other Health Outcomes in Older Adults with Dementia

Background: Since its inception in August 2008, Korea Long-Term Care Insurance (LTCI) program has undergone expansions to broaden coverage for dementia patients. In January 2018, the Cognitive Assistance Grade (CAG) was introduced, effectively extending LTCI to all dementia patients, granting them access to home-care services, including Day and Night Care. Although numerous studies have shown that expansions in LTCI are associated with reductions in informal care and medical costs, research on the impact of LTCI expansion on health outcomes—particularly in relation to dementia progression—remains limited. As mandated by the LTCI Act, this study aims to assess the differences in dementia progression and other health outcomes between CAG beneficiaries and non-beneficiaries. Additionally, this study seeks to examine the effects of LTCI service utilization on dementia progression among CAG beneficiaries.

Methods: This study, designed as a retrospective observational analysis, encompassing details on 50% of dementia patients in Korea. Using 1:1 exposure matching without replacement, based on a propensity score derived from patient characteristics, including dementia severity, CAG beneficiaries were paired with at-risk LTCI non-beneficiaries diagnosed with dementia. The primary outcome was cognitive decline, assessed via the cognitive function domain score in the LTCI assessment. Secondary outcomes included other indicators of dementia progression, such as cognitive enhancer dosage, delirium diagnoses, and emergency room visits primarily related to dementia. The study also evaluated mental and physical health outcomes, including depression diagnosis, mental and physical dependency, and all-cause mortality, with femur fracture diagnosis included as control outcomes. Dose-dependent associations with the frequency of LTCI service utilization were analyzed. Subgroup analyses were conducted based on baseline characteristics of dementia patients, LTCI facility characteristics, and type of LTCI service.

Results: A total of 8,511 CAG beneficiaries and 8,511 non-beneficiaries were included in the study. Cognitive decline was found to occur at a higher rate among CAG beneficiaries (HR: 3.329, 95% CI: 3.000–3.695) and poorer health outcomes compared to non-beneficiaries. Receiving LTCI services over 20 times per month was linked to a significantly lower risk of cognitive decline compared to non-utilization, following a dose-dependent decreasing trend (HR: 0.696, 95% CI: 0.598–0.809, p-for-trend: <0.0001). Similar results were observed among participants with mild cognitive symptoms, without behavioral symptoms, and under 85 years of age. This trend was consistent for home-visit LTC services, with a significant reduction in cognitive decline risk observed across all utilization frequencies (HR: 0.500, 95% CI: 0.295–0.847 for fewer than 10 times per month; HR: 0.564, 95% CI: 0.332–0.958 for 10–20 times per month; and HR: 0.501, 95% CI: 0.386–0.651 for More than 20 times/month; p-for-trend: <0.0001). No significant effect was found on Day and Night Care services. Among participants in Day and Night Care facilities with a staff-to-beneficiary ratio exceeding 1.0, a significant reduction in cognitive decline was observed with utilization More than 20 times/month (HR: 0.655, 95% CI: 0.456–0.940, p-for-trend: 0.0311).

Conclusion: Expanding LTCI to include non-beneficiaries with dementia and a broader range of other senile diseases beyond dementia could be beneficial, as LTCI services help slow cognitive decline, particularly with early intervention. Younger dementia patients and those with milder symptoms showed greater benefits, highlighting the importance of early LTCI involvement. Effective care also requires a higher staff-to-beneficiary ratio and beneficiary-tailored interventions. Cost-effectiveness must be considered as rising dementia rates and LTCI expenses place increasing pressure on resources. Despite the 2018 LTCI expansion to universal coverage, many individuals remain unenrolled. Further research is needed to explore baseline clinical differences between CAG beneficiaries and non-beneficiaries and to understand the reasons for not applying for LTCI.

Key words: Long-term care insurance, Health outcome, Insurance coverage expansion, Long-term care, Dementia, Universal coverage

I. INTRODUCTION

1.1. Study background

Korean Long-Term Care Insurance (LTCI), a national insurance program for older adults aged 65 and above or patients with senile diseases (such as dementia) who experience impairment in daily living, has been in effect since July 2008[1]. According to the Long-term Care Insurance Act, LTCI provides several benefits that encompass home care services (such as visiting care, bathing assistance, and nursing visits), institutional care services (admission to designated LTC institutions), and monetary benefits (including family care benefits and exceptional care benefits) [2]. The benefits under LTCI vary based on LTCI ratings, assessed using the LTCI score[3].

The LTCI score comprises five standardized domains: daily living function (12 items), behavioral problems (14 items), cognitive function (7 items), nursing demand (9 items), and rehabilitation demand (10 items). The overall score ranges from 0 to 100, with elevated scores indicating more severe disease.

The limited representation of cognitive function in the LTCI score (7 items among total 52 items), often precludes individuals with physically intact or mildly impaired dementia from qualifying for LTCI benefits[4]. This exclusion imposes substantial financial, mental, and physical burdens on caregivers of non-qualifying dementia patients[5-9]. Excessive caregiver burden is associated with adverse dementia outcomes, including cognitive decline, worsening behavioral symptoms, and decreased survival rates[10-12], further intensifying caregiver stress. Korea's rapidly aging population and increasing dementia prevalence (10.29% in 2020, projected to reach 15.91% by 2050) exacerbate this challenge[13,14].

To alleviate the challenges in LTCI, two significant expansions of LTCI beneficiaries occurred on July 1st, 2014 (First expansion) and January 1st, 2018 (Second expansion) [1]. Before July 2014, the system classified long-term care into three grades, with Grade 1 representing the most severe cases and Grade 3 the least severe. The first expansion restructured this into four grades and introduced Grade 5, specifically for dementia patients. The second expansion in January 2018 established the Cognitive Assistance Grade (CAG), aimed at extending LTCI coverage to physically intact or mildly impaired dementia patients.

1.2. Study objective

Following the program's second expansion, which was initially restricted to individuals with dementia, LTCI achieved extended coverage through the introduction of the CAG, enabling all dementia patients to qualify for LTCI upon completing administrative registration. For those receiving CAG benefits, the insurance specifically provides home care services that focus on comprehensive Day and Night Care. The Long-term Care Insurance Act outlines that the primary goals of LTCI are to enhance the health of senior citizens, provide stability for their life after retirement, reduce the caregiving responsibilities shouldered by families, and improve the overall quality of life[2]. The foremost aim is to better the health conditions of those covered.

Although many studies have shown that expansions and subsidies of LTCI correlate with decreases in informal caregiving and medical costs[15-19], research is sparse on the dose-dependent relationship between home care services and health outcomes within the universal LTCI framework. Furthermore, there is a lack of studies on the characteristics of dementia patients who, despite being eligible, have not applied for LTCI. Considering that the expansion of LTCI was specifically aimed at dementia patients, the principal objective should focus on enhancing the health status of this group, including efforts to slow the progression of dementia.

This research is designed to evaluate the association of LTCI expansion with health outcomes in dementia patients, compared with LTCI non-beneficiaries with dementia diagnosis. The primary outcome is the improvement in dementia progression, measured by changes in cognitive function domain scores based on LTCI scoring system. Secondary outcomes include additional dementia progression markers such as alterations in cognitive enhancer usage (both dosage and type), emergency care visits for dementia, and delirium diagnoses coupled with antipsychotic treatments. Furthermore, this study also investigates secondary mental and physical health outcomes like all-cause mortality, depression diagnosis with antidepressant treatment, and the occurrence of cardiovascular or cerebrovascular diseases. A comparative analysis of the dose-dependent trend based on LTCI benefit utilization and health outcomes between CAG beneficiaries and non-beneficiaries is also undertaken.

II. THEORETICAL BACKGROUND

2.1. Long-Term Care and Long-Term Care Insurance

Long-term care (LTC) is defined as continuous support for individuals with chronic disabilities or functional impairments, setting it apart from acute care that concentrates on diagnosing and treating conditions within hospital environments, generally covered by National Health Insurance (NHI) [20]. TC services, which include home care and institutional care, are essential in preserving well-being, independence, and community involvement, and they help prevent the institutionalization of both elderly and non-elderly individuals who face difficulties with daily activities[21]. LTCI was established and universally implemented for older adults to ensure standardized and systematized LTC, thereby alleviating the pressures on beneficiaries and their families.

LTCI is separate from the NHI system, which provides for acute care needs through services like hospitalization and outpatient care at hospitals, clinics, and pharmacies. Additionally, LTCI distinguishes itself from the welfare system by offering standardized and systematized long-term care, with the goal of reducing the impact on beneficiaries and their families[22].

2.2. Korea Long-Term Care Insurance

2.2.1. History of Korea Long-Term Care Insurance Alternation

LTCI was first officially introduced in Korea on July 1st, 2008, to address emerging medical demands due to an aging population, lack of informal care such as family members, and low fertility rates, mirroring trends in other countries (**Table 1**)[1,23]. Eligible beneficiaries included adults aged 65 and above or patients with senile diseases (**Table 2**) experiencing impairment in daily living.

The Long-term Care Insurance Act was enacted in 2007, followed by three pilot projects conducted by June 2008[1]. After LTCI's introduction, there were two major expansions of coverage and two minor expansions. Initially, until June 2012, the classification was as follows: Grade 1 for scores over 95 points, Grade 2 for 75-94 points, and Grade 3 for 55-74 points. The first minor

expansion occurred in July 2012, extending Grade 3 to cover 53-74 points. In July 2013, the second minor expansion further extended Grade 3 to 51-74 points.

The first major expansion of LTCI coverage took place in July 2014. It reclassified Grade 3 as 60-74 points, introduced Grade 4 for 51-59 points, and newly established Grade 5 for scores of 45-50 points with a dementia diagnosis. The second major expansion in January 2018 introduced the CAG for individuals scoring under 45 points with a dementia diagnosis.

The two major expansions of LTCI were specifically targeted at dementia patients due to the increasing prevalence and significant health and financial burdens associated with dementia in Korea[1]. As of 2022, the National Institute of Dementia in Korea reported that Dementia is diagnosed in 7.3% of people aged 60 and older[24]. Alzheimer's disease is the seventh leading cause of Korean mortality, with a mortality rate of 22.7 per 100,000 people[25]. The economic impact of dementia grew 1.5 times from 2015 to 2019. These challenges are worsened by the underdiagnosis and limited awareness of dementia[5].

Following the expansion of January 1st, 2018, all dementia patients became potentially eligible for LTCI benefits. However, to receive these benefits, individuals must apply for an eligibility assessment to the NHI and LTCI Need Assessment Committee. The committee determines eligibility based on a visit assessment and medical doctor evaluation[1]. Consequently, dementia patients who do not apply for LTCI cannot access its benefits, despite their potential eligibility.

Table 1. History of Korea long-term care insurance grade alteration

LTCI score	July 2008	July 2012	July 2013	July 2014	January 2018
100-95 points	Grade 1	Grade 1	Grade 1	Grade 1	Grade 1
94-75 points	Grade 2	Grade 2	Grade 2	Grade 2	Grade 2
60-74 points	Grade 3	Grade 3	Grade 3	Grade 3	Grade 3
55-59 points	Grade 3	Grade 3	Grade 3	Grade 4	Grade 4
53-54 points		Grade 3	Grade 3	Grade 4	Grade 4
51-52 points			Grade 3	Grade 4	Grade 4
45-50 points				Grade 5	Grade 5
0-44 points					CAG

Abbreviation: LTCI; long-term care insurance, CAG; Cognitive Assistance Grade

Table 2. Senile diseases for long-term care insurance eligibility

Disease	ICD-10
a. Dementia in Alzheimer's Disease	F00
b. Vascular Dementia	F01
c. Dementia in Other Diseases Classified Elsewhere	F02
d. Unspecified Dementia	F03
e. Alzheimer's Disease	G30
f. Subarachnoid Hemorrhage	I60
g. Intracerebral Hemorrhage	I61
h. Other Nontraumatic Intracranial Hemorrhage	I62
i. Cerebral Infarction	I63
j. Stroke, Not Specified as Hemorrhage or Infarction	I64
k. Occlusion and Stenosis of Precerebral Arteries, Not Resulting in Cerebral Infarction	I65
l. Occlusion and Stenosis of Cerebral Arteries, Not Resulting in Cerebral Infarction	I66
m. Other Cerebrovascular Diseases	I67
n. Cerebrovascular Disorders in Diseases Classified Elsewhere	I68
o. Sequelae of Cerebrovascular Disease	I69
p. Parkinson's Disease	G20
q. Secondary Parkinsonism	G21
r. Parkinsonism in Diseases Classified Elsewhere	G22
s. Other Degenerative Diseases of the Basal Ganglia	G23.4
t. Progressive Supranuclear Palsy	G23.4
u. Essential Tremor	R25.1
v. Amyotrophic Lateral Sclerosis	G12
w. Other Systemic Atrophies Primarily Affecting the Central Nervous System	G13
x. Multiple Sclerosis	G35

Abbreviation: ICD-10; International Classification of Diseases, Tenth Revision

2.2.2. Finances of Korea Long-Term Care Insurance

Korea's LTCI, while independent from NHI, operates on a national health insurance system model rather than a national health service system. This means it utilizes contribution-based financing instead of tax-based funding[26]. As of 2024, the LTCI contribution rate is set at 0.9182% of annual earnings (**Table 3**). Additionally, a national subsidy equivalent to 20% of the expected annual LTCI premium income is incorporated into the financing structure.

The system incorporates a coinsurance element for utilizing long-term care services. Beneficiaries are obligated to contribute 20% of the cost for institutional care services and 15% for home care services from their own pockets. Nonetheless, beneficiaries receiving medical aid program are completely exempt from these coinsurance obligations[1].

Table 3. Trend of annual increase in long-term care insurance contribution rate

Year	2018	2019	2020	2021	2022	2023	2024
Contribution rate (to annual income, %)	0.4605	0.5497	0.6837	0.7903	0.8577	0.9082	0.9182
Rate of increase (%)	14.9	19.4	24.4	15.6	8.5	5.9	1.09
Contribution rate (to health insurance contribution rate, %)	7.38	8.51	10.25	11.52	12.27	12.81	12.95

2.2.3. Methodology of Long-Term Care Insurance Scoring[1]

The LTCI score comprises 52 items across five domains (**Table 4**). The 'Daily living function' and 'Demand for rehabilitation' domains use a three-point scale, while the other domains employ a two-point scale. After initial scoring, raw scores for each area are converted to 'Domain-specific 100-Point Scores' using a predetermined conversion table.

These 100-point scores are then applied to tree regression analysis for eight service groups: hygiene, excretion, meals, functional assistance, behavioral change, indirect support, nursing care, and rehabilitation training. This analysis calculates the final LTCI score, representing the average time required to provide long-term care services per individual. The sum of these eight-service group LTCI scores determines the final LTCI grade.

For beneficiaries with dementia symptoms, a grade adjustment process is implemented using a specific regression model to identify individuals suspected of having dementia. If applicable, the

LTCI score is adjusted to the minimum score of the next higher grade. Additionally, the LTCI Need Assessment Committee may further adjust the grade after their evaluation.

Table 4. Five domains and 52 items of long-term care insurance scoring

Area	Item		
Daily living function (12 items)	◆ Taking off and wearing clothes ◆ Washing face ◆ Brushing teeth ◆ Bathing	◆ Eating ◆ Changing position ◆ Sitting up ◆ Moving to a chair	◆ Going out of the room ◆ Using the restroom ◆ Fecal incontinence ◆ Bladder incontinence
Cognitive function (7 items)	◆ Short-term memory impairment ◆ Orientation: date	◆ Orientation: location ◆ Recognizing age and date of birth	◆ Unable to follow instructions ◆ Impaired judgment ◆ Impaired communication and understanding
Behavioral problems (14 items)	◆ Hallucinations ◆ Delusions ◆ Changes in sleep patterns ◆ Wandering or agitation ◆ Resistance to help	◆ Repetitive, meaningless behaviors ◆ Unusual handling of money ◆ Aggressive behavior ◆ Leaving the room inappropriately	◆ Compulsive behavior ◆ Making inappropriate sounds or actions ◆ Experiencing sadness, with or without crying ◆ Inappropriate clothing ◆ Inappropriate toileting
Nursing demand (9 items)	◆ Tube feeding ◆ Aspiration care ◆ Stoma care	◆ Tracheostomy care ◆ Urinary catheter care ◆ Pressure ulcer care	◆ Cancer pain management ◆ Oxygen therapy ◆ Dialysis care
Rehabilitation demand (10 items)	**Mobility (4 items)**	◆ Right upper extremity limitation ◆ Left upper extremity limitation	◆ Right lower extremity limitation ◆ Left lower extremity limitation
	Joint Restrictions (6 items)	◆ Wrist and finger joints ◆ Shoulder joint ◆ Elbow joint	◆ Hip joint ◆ Knee joint ◆ Ankle joint

2.2.4. Benefits of Korea Long-Term Care Insurance[1]

Korea's Long-Term Care Insurance (LTCI) system provides two primary categories of benefits, with the first being home care services. These services offer daily support either at the beneficiary's home or in designated facilities for periods shorter than a day. The types of home care services include home visit nursing, where a nurse or assistant nurse provides care and consultation under a

doctor's instructions; : home visit care, which supports daily activities and household chores through visits to beneficiaries' homes; day and night care, offering institutional care services on an hourly basis; home visit bathing; short-term respite care, which provides care in LTCI facilities for up to 9 days per month; and the provision of assistive equipment. All LTCI beneficiaries have access to home care services. Under LTCI, while all beneficiaries have access to various home care services, there are specific restrictions for those classified under the CAG, which typically includes individuals with the mildest forms of dementia. Beneficiaries in this category are exclusively entitled to 'Day and night care'.

The second principal benefit under Korea's LTCI is institutional care service, which includes admission to LTCI-designated facilities capable of accommodating more than 10 beneficiaries, or to community-based LTCI homes that can house between 5 and 9 beneficiaries. Typically, individuals classified as LTCI Grade 3 or lower are ineligible for institutional care. Additionally, the use of both home care and institutional services simultaneously is prohibited.

LTCI also extends monetary benefits under specific conditions. For instance, a monthly cash benefit of 229,070 Korean won is allocated to beneficiaries residing in remote or isolated areas, or to those who are unable to access LTC services at designated facilities due to circumstances like natural disasters, physical or mental impairments, or personality issues. This benefit is applicable when recipients receive care equivalent to home care from family members or relatives.

2.2.5. Current Status of Korea Long-Term Care Insurance[27]

As of 2022, the population of Korean older adults aged 65 and above totaled 9,377,049, with 1,019,130 (10.9%) enrolled in the Long-Term Care Insurance (LTCI), marking a 6.9% increase from 2021 (**Table 5**). Among the LTCI enrollers, 23,273 beneficiaries (2.28% of total LTCI beneficiaries) were covered under the Caregiver Assignment Guideline (CAG), as detailed in **Table 6**.

Table 5. Trend of annual increase in long-term care insurance beneficiaries

	2018	**2019**	**2020**	**2021**	**2022**
Older adults (65 years or above)	7,611,770	8,003,418	8,480,208	8,912,785	9,377,049
LTCI beneficiary	670,810	772,206	857,984	953,511	1,019,130
Ratio of beneficiaries to older adults	8.8%	9.6%	10.1%	10.7%	10.9%

Abbreviation: LTCI; long-term care insurance

Table 6. The number of long-term care insurance beneficiaries in 2022

	Total	**Male**	**Female**
Grade 1	49,946	13,152	36,794
Grade 2	94,233	24,041	70,192
Grade 3	27,8520	79,490	199,030
Grade 4	459,316	128,840	330,476
Grade 5	113,842	32,635	81,207
CAG	23,273	7,312	15,961
Total	1,019,130	285,470	733,660

Abbreviation: CAG; Cognitive Assistance Grade

Among LTCI beneficiaries, a total of 999,451 beneficiaries had utilized benefits of LTCI. Financially, the LTCI program incurred costs totaling 11,444.2 billion Korean won for the year, averaging 1,234,556 Korean won per beneficiary. This expenditure was divided between home care services, which accounted for 7,092.2 billion Korean won, and institutional care services, which amounted to 4,346.5 billion Korean won, as shown in **Table 7.**

CAG beneficiaries receive 'Day and night care' services, which are specialized home care offerings allowing for eight-hour daily admissions to designated facilities up to 12 times per month, providing both physical and cognitive support[1]. These programs include cognitive training, reminiscence therapy, and art therapy, enhancing their daily treatment and support. On average, CAG beneficiaries utilized these services 12.5 times each month, with each session lasting approximately 7.9 hours. Furthermore, 71.1% of these beneficiaries participated in cognitive activity programs as part of their care[28].

Table 7. Trend of annual increase in long-term care insurance beneficiaries and share cost

	2018		2019		2020		2021		2022	
Number of LTCI beneficiaries who received benefits	648,792		732,181		807,067		899,113		999,451	
LTCI share cost per beneficiary (Korean won)	1,077,291		1,159,922		1,189,071		1,201,390		1,234,554	
LTCI share cost (billion Korean won)	62,992		77,363		88,827		100,957		114,442	
Home care services (billion Korean won, %)	3,434	100.0	4,370	100.0	5,230	100.0	6,191	100.0	7,092	100.0
Home-visit care (billion Korean won, %)	2,436	70.9	3,007	68.8	3,589	68.6	4,215	68.1	4,810	67.8
Home-visit bathing (billion Korean won, %)	100	2.9	116	2.7	136	2.6	163	2.6	191	2.7
Home-visit nursing (billion Korean won, %)	17	0.5	22	0.5	2,631	0.5	32	0.5	35	0.5
Day and Night care (billion Korean won, %)	736	21.4	1,044	23.9	1,273	24.3	1,537	24.8	1,783	25.1
Short-term care (billion Korean won, %)	12	0.4	11	0.3	9	0.2	7	0.1	7	0.1
Welfare equipment (billion Korean won, %)	132	3.8	169	3.9	198	3.8	238	3.8	268	3.8
Institutional care services (billion Korean won, %)	2,865	100.0	3,366	100.0	3,653	100.0	3,904	100.0	4,347	100.0
LTCI facilities (billion Korean won, %)	2,588	90.3	3,063	91.0	3,342	91.5	3,592	92.0	4,033	92.8
Community-based LTCI homes (billion Korean won, %)	277	9.7	303	9.0	311	8.5	312	8.0	314	7.2
Others (billion Korean won, %)	-	-	-	-	-	-	1	100.0	6	100.0

Abbreviation: LTCI; long-term care insurance

2.2.6. Structure and Status of Long-Term Care Insurance in Other Countries

Among the 38 nations in the Organization for Economic Cooperation and Development (OECD), including Korea, adults aged 65 and older made up less than 9% of the population in 1960, increased to 18% by 2020, and is projected to rise to 27% by 2050, indicating a growing pool of potential beneficiaries for LTCI[29]. The percentage of LTCI beneficiaries among older adults stood at 11.5% across 28 OECD countries, a figure that aligns closely with that in Korea[29]. Additionally, during the years 2019 to 2020, about 50% of older adults in 22 OECD countries with impairments in more than one instrumental activity of daily living (iADL) or activity of daily living (ADL) reported an unmet need for LTC[29]. From a financial perspective, the share of LTC expenditures relative to GDP increased from 0.9% in 2004 to 1.4% in 2020, marking a 57% increase. This figure is expected to further escalate to 2.3% by 2040[30].

In the United States, LTC encompasses home health care services along with community and residential care options such as nursing homes and adult day care centers, predominantly funded through Medicaid or Medicare[31]. In Japan, LTC is offered through facility services, community-based services, and in-home services, including a preventive LTC benefit specifically for older adults who are not yet eligible for full benefits[32]. In the Netherlands, following reforms to the LTCI system in 2015, only inpatient services are provided to older adults and the disabled who require intensive, round-the-clock care[33]. Conversely, in England and Germany, the structure of LTCI benefits mirrors that of Korea, comprising both home-care services and institutional care services, providing a comprehensive support system for individuals requiring LTC[1].

In a topology study conducted among 25 OECD countries, long-term care systems were classified into six types based on various indicators. These indicators include supply measures such as expenditure per capita and number of beds, public-private mix elements like the share of private expenditure, access regulation measures including regulations for home care and institutional care providers, and performance metrics such as life expectancy and self-perceived health status[34]. Korea and Japan fall into the category of an evolving public supply system. This system is characterized by a relatively low number of beds and low cash benefits, alongside high restrictions on the choice of benefits and a high life expectancy. In contrast, several European countries are categorized under the need-based supply system, which is marked by a high number of beds and high cash benefits, low restrictions on benefit choice, and a medium level of life expectancy[34]. These classifications highlight distinct approaches to LTC based on regional priorities and demographic challenges.

2.3. Previous Research: Long-term care insurance and health outcomes

Despite the significant impact of Long-Term Care Insurance (LTCI) expansion on healthcare services, research exploring the effect of LTCI introduction on health outcomes, particularly in relation to dementia, has been relatively sparse and has received less attention than studies on healthcare expenditures. Additionally, previous studies investigating the linkage between LTCI and health status have presented inconclusive results and faced various limitations, including brief follow-up duration and limited sample sizes.

In France, the availability of public financial assistance for home care services for dementia patients has been linked to a reduction in emergency care utilization among beneficiaries compared to those not receiving benefits[35]. In Spain, the expansion of LTCI coverage has been associated with a lower hospital admissions and utilization, as well as a lower prevalence of depressed mood and suicidal ideation among beneficiaries[36]. In Japan, while LTCI has not shown any discernible positive effects on overall health outcomes[37], more advanced care provided under LTCI was found to delay the progression of impairments in daily living activities[38]. In China, the implementation of LTCI has led to improvements in ADL, cognition level, perceived health status, and a decrease in mortality rates[39-43]. Additionally, enhanced access to social care services through LTCI expansion in China has been linked with a decrease in hospital readmissions[44]. In Korea, following the implementation of the CAG, there were no significant changes observed in cognitive function and depression levels one year after the introduction of the policy compared to the period before its implementation[28,45]. However, a decreased risk of all-cause mortality was associated with the utilization of LTCI services in Korea[46].

2.4. Conceptual framework for health effect of long-term care insurance

The direct and indirect health effects of LTCI and its benefits can be elucidated using the Theory of Planned Behavior (TPB) [47,48]. Health outcomes are influenced by health behaviors, which operate at three levels: lifestyle and behavioral, psychological and motivational, and spiritual and meaningful[49]. The critical point in the decision-making process regarding health behavior is intention, which is shaped by one's attitude towards improving health conditions, subjective norms influenced by the surrounding environment, and perceived behavioral control over enhancing health status (**Figure 1**).

In terms of the health effects of LTCI, a favorable attitude is supported by registration in the LTCI program. Favorable social norms may arise from interactions with other LTCI beneficiaries within the same long-term care facilities or from family members. Enhanced perceived behavioral control can be achieved through various LTCI interventions, including dementia management education. Additionally, there is a mutual influence between perceived behavioral control and attitude through a positive feedback loop; for example, a favorable attitude can lead to proactive behavior, which improves measures of perceived behavioral control.

A positive attitude toward better management of dementia conditions, coupled with higher social pressure and enhanced perceived behavioral control, leads to a proactive intention. This proactive intention, along with better perceived behavioral control, can prompt therapeutic behaviors aimed at slowing dementia progression. Such behaviors may include active participation in dementia education programs, regular reassessment of dementia, preventive practices in daily living to slow dementia progression, and active therapeutic and non-therapeutic management of dementia symptoms.
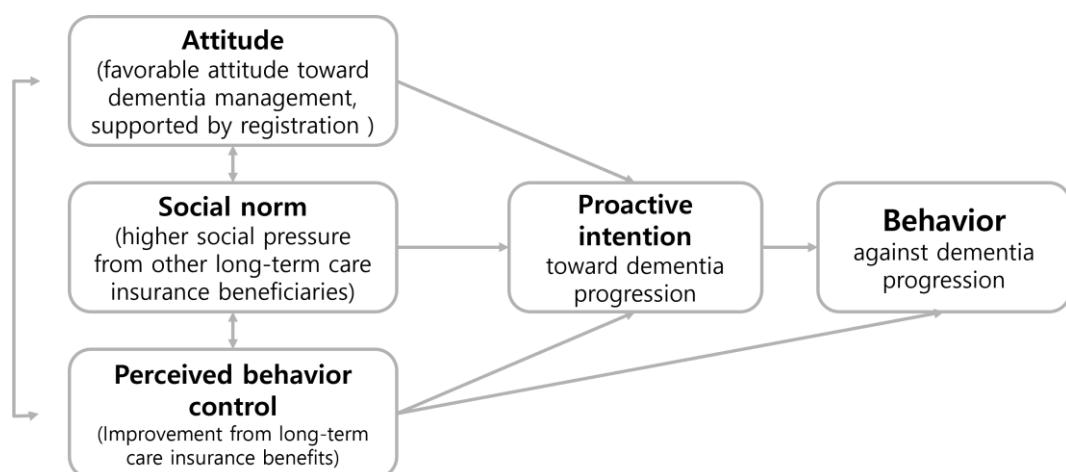
Figure 1. Conceptual framework for the health effect of long-term care insurance based on theory of planned behavior

III. METHODS

3.1. Data source

This research employed data from the Korea National Health Insurance Service-National Health Information Database (NHIS-NHID) spanning January 1, 2013, to December 31, 2022. The selected period covers from the introduction of Grade 5 in LTCI to the latest available data. NHIS-NHID is a demand-driven database, systematically collected and maintained by the Korean NHI, which functions under an obligatory single-insurer system providing universal health coverage to all citizens and medical providers.

The study population was characterized by using a range of variables including sociodemographic factors, health insurance status, mortality records, prescription statistics, and diagnostic records. The follow-up for participants extended until December 31, 2022, or until earlier disqualification from NHI, such as death, or emigration.

The study received approval from the Institutional Review Board (IRB) of Severance Hospital in Seoul, Republic of Korea (IRB No: [4-2023-1131]).

3.2. Study participants

The research encompassed all patients diagnosed with dementia, utilizing the International Statistical Classification of Diseases and Related Health Problems, 10th Revision (ICD-10) for case identification. According to the Long-term Care Insurance Act in Korea, dementia diagnoses eligible for LTCI coverage include Alzheimer's disease (G30), dementia in Alzheimer's disease (F00), vascular dementia (F01), dementia in other diseases classified elsewhere (F02), and unspecified dementia (F03). The onset date of dementia was established as the earlier of two possible dates: the initial dementia diagnosis date or the date when the patient first started using cognitive enhancers—such as donepezil, galantamine, rivastigmine, or memantine, for a minimum of 90 days prescription. Owing to constraints related to the dataset size and analytical tools, a random selection of half the eligible participants among every dementia patient in Korea was included in the study.

The index date, or time-zero, for this study was set as the start date of the CAG, rather than the date of LTCI registration. The follow-up period was determined as the duration from the index date to either the occurrence of study outcomes, the cutoff date of December 31, 2022, disqualification

from the NHI due to reasons such as emigration, or death, whichever came first.

Out of 1,438,298 participants in the NHIS-NHID who had been diagnosed with dementia or prescribed cognitive enhancers at least once, six criteria were applied to select eligible participants (**Figure 2**). First, to exclude potential misdiagnoses and illegal proxy prescriptions, only individuals with at least three outpatient visits for a dementia diagnosis were included. Second, a 2-year washout period was applied to investigate newly diagnosed dementia cases following the introduction of LTCI. Third, dementia patients whose initial start date for CAG was after December 31st, 2022, the study's end date, were excluded. Fourth, to explore the relationship between LTCI coverage expansion and health outcomes, participants with pre-existing conditions such as LTCI Grades 1-5, prior delirium diagnosis within three years of index date, and prior geriatric depression diagnosis within three years of index date were excluded to consider newly occurred outcomes. Fifth, the follow up duration was longer than 6 months and to exclude other acute factors that induced outcomes. Sixth, participants with missing covariate data, including biannual health screening date, were excluded.

During the elimination of missing data, individuals lacking information from biannual health assessments were omitted, resulting in the exclusion of over half the participants. Health screenings serve as a marker for the health-related behavior of older adults. Particularly, this correction was crucial given that beneficiaries of LTCI and their caregivers, who must opt into the program, tend to have a greater focus on monitoring and actively managing dementia. This increased vigilance and preemptive management of dementia care could possibly affect the study results, necessitating its consideration in the evaluation. Also, taking health screening within 3 years was a substantial risk factor for older adults with LTCI, then we included older adults with dementia who had taken screening[50].
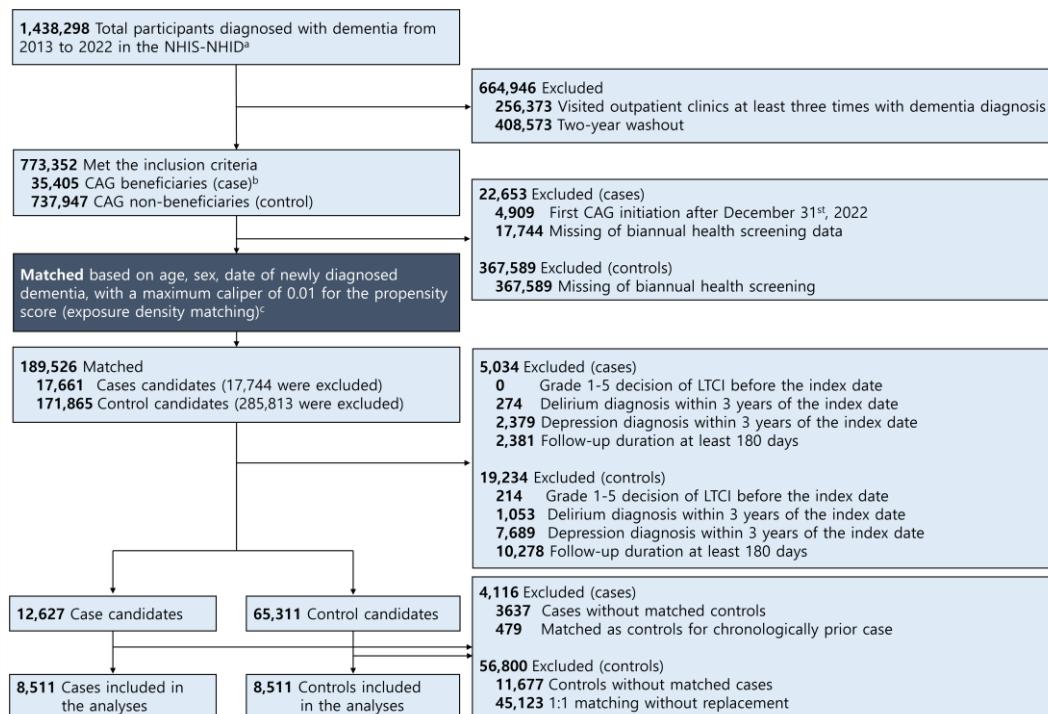
Figure 2. Flow chart of participant selection

Abbreviation: NHIS-NHID; Korea National Health Insurance Service-National Health Information Database, CAG; Cognitive Assistance Grade, LTCI; Long-term care insurance

a NHIS-NHID, spanning from January 1, 2013, to December 31, 2022, NHID is a demand-driven database, systematically collected and maintained by the Korean NHI, which functions under an obligatory single-insurer system providing universal health coverage to all citizens and medical providers.

b CAG beneficiaries were classified as cases, with the index date established as the commencement of CAG.

c Matched was based on sex (male or female), age (within one year), date of dementia diagnosis (within 6 months) and cumulative dose of cognitive enhancers during the 6 months before and after the index date, categorized into four ordinal groups. A time-dependent propensity score was calculated from age, sex, year of dementia diagnosis, income level, area of residence, National Health Insurance type, exercise level, smoking status, alcohol consumption, number of hospital admissions, average annual outpatient visits, and Charlson Comorbidity Index.

3.3. Study Design

3.3.1 Retrospective Observational Study

A retrospective observational study was accepted involving LTCI beneficiaries with Grade 5 or CAG and dementia patients who were non-beneficiaries of LTCI. The simultaneous introduction of LTCI for all eligible NHI beneficiaries in Korea precluded a prospective study, as withholding LTCI benefits from a control group would raise ethical concerns, particularly in the analysis of the second major expansion (CAG introduction). To minimize selection bias inherent in retrospective studies, half of all participants in Korea who had been diagnosed with dementia or had ever used cognitive enhancers during the study period were included.

3.3.2 Establishment of 'Cognitive Assistance Grade' and Matched Controls

The analysis aimed to explore the difference between CAG beneficiaries and non-beneficiaries, and association between having LTC benefit and various health outcomes. Therefore, dementia patients with CAG were defined as cases. A propensity score was calculated and exposure matching was conducted to control for confounding factors and emulate a prospective study design[51]. The propensity score at the date of dementia diagnosis was calculated using several variables, including age, sex, year of dementia diagnosis, income level, area of residence, NHI type, exercise level, smoking status, alcohol consumption, number of hospital admissions, average annual outpatient visits, and Charlson Comorbidity Index (CCI) except dementia diagnosis. Except for age, all variables were treated as categorical.

Each CAG beneficiary was matched based on propensity score to dementia patients who were at risk of becoming LTCI beneficiaries at the shared index date. During the matching process, the following variables were exactly matched to ensure that the eligible control group closely resembled the LTCI beneficiaries: sex; male or female, age; difference less than one year, date of dementia diagnosis; within six months and cumulative dose of cognitive enhancer. The cumulative dose of cognitive enhancers was classified into four subgroups based on the World Health Organization cumulative defined daily doses (cDDDs) over the six months before and after to the index date (total 12 months): less than 30 cDDDs/12 months, 30-180 cDDDs/12 months, 180-365 cDDDs/12 months, and more than 365 cDDDs/12 months. Following the matching process, participants were diagnosed with delirium or depression within three years before the shared index date and those with less than six months of follow-up duration were excluded. Exclusions for diagnoses of delirium and

depression were implemented to maintain a consistent severity of dementia and to utilize these conditions as outcome measures. Additionally, any cases lacking corresponding controls were removed, and similarly, controls without cases were also excluded.

A 1:1 propensity score matching was conducted for each risk set using a nearest matched set within a caliper of 0.01. Before matching, 1 percentile trimming was conducted based on the distribution of propensity score in order to better matching. Additionally, some LTCI beneficiaries could be included as matched controls for other earlier LTCI beneficiaries, as they might have been selected as matched control subjects before becoming beneficiaries themselves. To avoid overlapping in the risk set, dementia patients who were later included as LTCI beneficiaries were excluded from the control group to ensure non-overlapping samples[52]. This exposure matching method was then repeated sequentially for each subsequent patient until the last LTCI beneficiary had been successfully matched[53].

3.4. Outcomes

3.4.1 Primary outcome: Dementia progression

Due to data limitations, including the absence of diagnostic codes for dementia severity and the lack of dementia screening scores or neuropsychological test results, proxy indicators needed to be employed to assess dementia progression. Therefore, cognitive function domain score was selected as proxy indicator of cognitive decline. Cronbach's coefficient alpha of cognitive function domain score was 0.725.

Cognitive function evaluation in LTCI is comprised with 7 items including short-term memory impairment, orientation to time, orientation to place, recognizing age and date of birth, unavailability of following instructions, impaired judgment, and impaired communication and understanding, which were determined based on several verified screening tools and medical specialists[54,55]. Each item were evaluated and resulted in binary outcome (score 1 for yes and 0 for no, maximum total score 7)[4]. In our study, cognitive decline was defined as increase at least 3 points in cognitive domain score out of 7 points, determined by previous research regarding cognitive domain score change (2~3 items) after introduction of Grade 5 in LTCI[56].

3.4.2 Secondary outcomes

Secondary outcomes included other proxy indicators for dementia progression, and physical or mental health outcome. Other proxy indicators for dementia progression were as follows: delirium diagnosis within three years before the shared index date with antipsychotic usage (such as haloperidol, risperidone, olanzapine, quetiapine, ziprasidone, aripiprazole, paliperidone, clozapine, amisulpride, blonanserin, zotepin). Delirium diagnosis of outpatient visits at least 3 times or 1 admission with primary or first secondary diagnosis was included. As antipsychotics are commonly prescribed for various behavioral and psychological symptoms in dementia including delirium, the use of antipsychotics were also accompanied with delirium diagnosis as secondary outcome[57,58]. Emergency room visits under dementia diagnosis (visits with dementia as the primary diagnosis or first secondary diagnosis with primary diagnosis of dementia symptoms).

The first use or dosage increase of cognitive enhancers lasting at least 90 days was selected as a proxy indicator for dementia progression. Dosage sustenance duration was defined based on the observation that new or increased use of cognitive enhancers is typically maintained for 4–8 weeks to monitor side effects[59]. The use of memantine was considered a proxy indicator of moderate-to-severe dementia, aligned with its clinical indication[60,61]. Consequently, four indicators of dementia progression based on cognitive enhancer dosage were selected: initial use or dosage increase of cognitive enhancers, initial use or dosage increase of memantine, maximum dosage administration of cognitive enhancers (23 mg per day for donepezil, 20 mg per day for memantine, 12 mg per day for oral rivastigmine, or 13.3 mg/24 hours for rivastigmine patch, and 24 mg per day for galantamine), and maximum dosage administration of memantine.

In physical or mental health outcomes, all-cause mortality, provision of LTCI Grade 1 or 2 which mean physical and mental dependence, newly diagnosed depression with antidepressant usage (prescribed at least 90 days after depression diagnosis, such as fluoxetine, paroxetine, sertraline, escitalopram, vortioxetine, venlafaxine, desvenlafaxine, duloxetine, milnacipran, mirtazapine, trazodone, tianeptine sodium, bupropion, agomelatine), cardiovascular or cerebrovascular diseases diagnosis were included.

Diagnosis of femur fracture was selected as controls of outcomes, considered as not directly associated with dementia progression.

3.5. Covariates

Socioeconomic characteristics at the date of dementia diagnosis were included: area of residence (province, capital area, and metropolitan area), economic status (classified by three groups based on NHI premium amount), and insurance type (employee, self-employed, and others).

Health status factors at the time of dementia diagnosis included level of physical activity categorized as sufficiently active (>600 metabolic equivalents of task [MET]-minutes/week), insufficiently active (≤600 MET-minutes/week), or inactive [62,63]. Additionally, alcohol drink level was classified as current drinker (>once/week) or social drinker (≤once/week) or while smoking status was categorized as three subgroups: current smoker, past smoker (who smoke more than 100 cigarettes in their lifetime, they do not currently smoke), or non-smoker (who smoke less than 100 cigarettes in their lifetime). Average annual outpatient visits during three years before the index date (<12, 12-36, >36 visits), and number of hospital admissions during three years before the index date (no admission, 1 time, 2 times or more) were also included. Additionally, CCI score except dementia diagnosis was calculated based on claim data during recent three years before the index date (CCI score 0, 1, 2, and 3 or higher) was applied for comorbidity adjustment[64].

Physical activity, alcohol consumption level, and smoking status were derived from the most recent biannual national screening results within 2 years of the index date[65]. Other covariates were derived from claim or administrative data. Disease presence for CCI calculation was defined as one admission or at least three outpatient visits by primary or first secondary diagnosis. All ICD-10 code or Korea ingredient code for medication are listed in **Supplementary table 1.**

3.6. Statistical Analysis

Baseline characteristics between CAG beneficiary and control groups were compared using standardized differences, with values below 0.1 (<10%) generally considered negligible[66]. All covariates were included in the analysis, and with a maximum variance inflation factor (VIF) of 1.48, no evidence of multicollinearity was detected in the data.

The analysis aimed to examine differences in the risk of dementia progression and other health outcomes between LTCI non-beneficiaries and LTCI beneficiaries. The incidence ratio (IR) of outcomes, along with a 95% confidence interval (CI), was calculated using a generalized linear model with a Poisson distribution and expressed as outcomes per 1,000 person-years. The shared index date was determined at the date of LTCI benefit initiation for both CAG beneficiaries and

matched controls. Survival time was measured from the shared index date to the outcome occurrence, death, NHI disqualification, or the study's end (December 31, 2022), whichever occurred first. The findings were obtained through a Cox proportional hazards model applied to matched case and control sets and presented as hazard ratios (HR). The cumulative incidence of cognitive decline was assessed applying Kaplan-Meier survival curves, and the stratified log-rank test was applied[68].

To explore the dose-dependent relationship between the amount of LTCI benefits received and dementia progression, discrete-time survival model was conducted using a complementary log-log link function[67]. The effect size was presented as HR. This model assesses the association between the cumulative amount of LTC services received in a preceding six-month period and the risk of dementia progression in the following three-month period, ensuring no overlap between the six-month cumulative period and the three-month outcome period (six-month for cumulation and three-month for outcome occurrence). Six-month intervals were sustained from the index date until the occurrence of the outcome, death, NHI disqualification, or the study's end date (December 31, 2022), whichever came first. LTCI beneficiaries who used LTC services were divided into four subgroups based on the frequency of service use: no LTC service, less than 10 times/month, 10–20 times/month, and more than 20 times/month. The cumulative amount of LTC services during each six-month period was calculated by summing the total number of days each beneficiary claimed these services from the NHI. Additionally, all types of home-visit services excluding assistive equipment provision were mainly considered in the analyses (home visit bathing, care, and nursing, short-term care, and Day and night care), two other subgroups were defined based on the type of LTC service utilized: services limited to Day and night care, home-care services delivered directly at the residence of the beneficiary (including home visit bathing, care, and nursing). Trend analyses (expressed as p-for-trend) were applied using LTC service utilization subgroups as ordinal variables to explore dose response trends within a logistic model[69].

To investigate associations in detail, subgroup analyses were conducted focused on the severity of cognitive and behavioral symptoms in dementia. Domain scores from the LTCI scoring system were used to examine the nuanced effects of CAG beneficiary status and LTC services across varying symptom severities in dementia patients. LTCI beneficiaries were categorized into subgroups based on cognitive function and behavioral problem scores: mildly impaired cognitive function, significantly impaired cognitive function (defined as scoring at least 3 positive items out of 7 in the cognitive function domain, with CAG beneficiaries in this study averaging 2 out of 7

positive points), and by the presence or absence of behavior problems. The characteristics of the institutions providing these services were also considered, with LTC institution capacity categorized as less than 30, 30–60, and more than 60. The number of staff, including nurses, social workers, and nursing care workers (categorized as fewer than 10, 10–30, and more than 30 workers), along with the ratio of staff to current beneficiaries at each facility (categorized as less than 0.5, 0.5–1.0, and more than 1.0), were considered in the analysis. These LTC facility characteristics were considered only for Day and Night Care services, not for home-visit LTC services.

Additionally, subgroup analyses were performed based on sex (male and female), age (less than 75 years, 75 to 85 years, more than 85 years), COVID-19 pandemic (using January 1st, 2020, as the cutoff date), the severity of dementia as determined by cognitive enhancer dosage, and the type of dementia at the index date. Dementia severity was classified as follows: participants taking over 360 cDDDs of donepezil, rivastigmine, or galantamine in the six months before the index date, or those who had ever used memantine, were categorized as severe. Those who had never used cognitive enhancers were categorized as mild, while the remaining participants were classified as moderate.

Several sensitivity analyses were conducted using alternative benchmarks for cognitive decline, measured by increases in cognitive domain scores in increments of 1, 2, 4, or 5 out of 7 points instead of the standard 3 out of 7 points. Another analysis included a separate LTCI category (Grade 5, LTCI score 45-50) as a control group for the CAG to account for health behaviors associated with LTCI enrollment. In this analysis, matching was further refined based on cognitive function domain scores, exactly matched physical activity level, and based on another classification of cumulative cognitive enhancer dosage due to small sample size. Additionally, alternative intervals were used for cumulative LTC service usage (three-month for cumulation and three-month for outcome, one-year for cumulation and three-month for outcome, and six-month for both cumulation and outcome).

All statistical analyses were conducted using SAS Enterprise Guide (version 9.4; SAS Institute), with a two-tailed p-value of less than 0.05 set as the threshold for significance.

IV. Results

4.1. Baseline characteristics of participants

17,022 participants met the inclusion criteria, consisting of 8,511 CAG beneficiaries and 8,511 matched controls. **Table 8** presents the baseline characteristics and standardized differences for evaluating covariate balance between the CAG beneficiary and control groups. The mean age for both groups was 78.0 years (standard deviation [SD]: 5.8 years), with 70.5% female participants in each group.

In both groups, less than 30 cDDDs of cognitive enhancers were dispensed as follows: 18.6% for donepezil, 98.5% for rivastigmine, 98.8% for galantamine, and 96.8% for memantine. For donepezil use within the six months before and after the index date, 30.5% received 30–180 cDDDs per year, 33.8% received 180–365 cDDDs per year, and 17.1% received more than 365 cDDDs per year. Nearly half of the participants resided in provincial areas (48.9% of CAG beneficiaries and 50.1% of controls), while over half were classified as having high economic status.

No differences were observed between the CAG beneficiary group and the control group in precisely matched characteristics, including age, sex, and cumulative cognitive enhancer dosages within six months before and after the index date. Furthermore, no significant differences were noted across other socioeconomic and health-related characteristics between case and control.

Table 8. Baseline characteristics of the study participants

Variables	Matched controls		CAG beneficiaries		Standardized difference
	n or mean	(%) or (SD)	n or mean	(%) or (SD)	
Total	8511	(100)	8511	(100)	
Age (years)	78.0	(5.8)	78.0	(5.8)	-0.025
Cumulative dosage of cognitive enhancers					
Donepezil					0.000
Less than 30 cDDDs/year	1586	(18.6)	1586	(18.6)	
30-180 cDDDs/year	2597	(30.5)	2597	(30.5)	
180-365 cDDDs/year	2873	(33.8)	2873	(33.8)	
More than 365 cDDDs/year	1455	(17.1)	1455	(17.1)	
Rivastigmine					0.000
Less than 30 cDDDs/year	8386	(98.5)	8386	(98.5)	
30-180 cDDDs/year	77	(0.9)	77	(0.9)	
180-365 cDDDs/year	36	(0.4)	36	(0.4)	
More than 365 cDDDs/year	12	(0.1)	12	(0.1)	
Galantamine					0.000
Less than 30 cDDDs/year	8406	(98.8)	8406	(98.8)	
30-180 cDDDs/year	71	(0.8)	71	(0.8)	
180-365 cDDDs/year	27	(0.3)	27	(0.3)	
More than 365 cDDDs/year	7	(0.1)	7	(0.1)	
Memantine					0.000
Less than 30 cDDDs/year	8238	(96.8)	8238	(96.8)	
30-180 cDDDs/year	213	(2.5)	213	(2.5)	
180-365 cDDDs/year	59	(0.7)	59	(0.7)	
More than 365 cDDDs/year	1	(0.0)	1	(0.0)	
Sex					0.000
Male	2510	(29.5)	2510	(29.5)	
Female	6001	(70.5)	6001	(70.5)	
Year of dementia diagnosis					-0.022
2015	551	(6.5)	547	(6.4)	
2016	793	(9.3)	804	(9.4)	
2017	1170	(13.7)	1138	(13.4)	
2018	1707	(20.1)	1711	(20.1)	
2019	1595	(18.7)	1570	(18.4)	
2020	1385	(16.3)	1380	(16.2)	
2021	1146	(13.5)	1154	(13.6)	
2022	164	(1.9)	207	(2.4)	
Area of residence					0.020
Capital area	2636	(31.0)	2706	(31.8)	
Metropolitan	1615	(19.0)	1647	(19.4)	
Province (rural)	4260	(50.1)	4158	(48.9)	
Economic status					0.061
Low	1552	(18.2)	1776	(20.9)	
Middle	1769	(20.8)	1839	(21.6)	
High	5190	(61.0)	4896	(57.5)	
Insurance type					-0.011
Self-employed	1486	(17.5)	1475	(17.3)	
Employee	211	(2.5)	144	(1.7)	

Others	6814	(80.1)	6892	(81.0)	
Disability					-0.024
Without disability	7233	(85.0)	7032	(82.6)	
With disability	1278	(15.0)	1479	(17.4)	
Physical activity					0.066
Inactive	4874	(57.3)	5145	(60.5)	
Insufficiently active	1229	(14.4)	1246	(14.6)	
Sufficiently active	2408	(28.3)	2120	(24.9)	
Alcohol status					0.004
Social drinker	4473	(52.6)	4504	(52.9)	
Current drinker	4038	(47.4)	4007	(47.1)	
Smoking status					-0.013
Non-smoker	7162	(84.1)	7109	(83.5)	
Past smoker	1102	(12.9)	1096	(12.9)	
Current smoker	247	(2.9)	306	(3.6)	
Number of outpatient visits (recent 3 years)					0.022
less than 12 times/year	982	(11.5)	1133	(13.3)	
12-24 times/year	2161	(25.4)	2081	(24.5)	
24-48 times/year	3211	(37.7)	3101	(36.4)	
more than 48 times/year	2157	(25.3)	2196	(25.8)	
Number of admissions (recent 3 years)					-0.018
no admission	3840	(45.1)	3785	(44.5)	
1 time	1850	(21.7)	1810	(21.3)	
more than 2 times	2821	(33.1)	2916	(34.3)	
Charlson Comorbidity Index					-0.010
0	2629	(30.9)	2681	(31.5)	
1	2662	(31.3)	2566	(30.1)	
2	1569	(18.4)	1519	(17.8)	
3 or higher	1651	(19.4)	1745	(20.5)	

Abbreviation: CAG; Cognitive Assistance Grade, cDDDs; cumulative defined daily doses

4.2. The association between being a beneficiary after the expansion of long-term care insurance and dementia progression

Figure 3 illustrates the cumulative incidence of the primary outcome, cognitive decline, throughout the entire follow-up period, with statistical significance observed (p < 0.0001, log-rank test). Participants with a follow-up duration of less than 180 days were excluded from the analysis.

Supplementary Table 2 presents the association between the expansion of and dementia progression, along with other health outcomes. The mean follow-up duration was 851 days (SD: 442) for non-beneficiaries and 804 days (SD: 439 days) for CAG beneficiaries. Compared to the matched control group, CAG beneficiaries showed a higher likelihood of cognitive decline (HR: 3.329, 95% CI: 3.000–3.695). Secondary outcomes related to dementia progression, such as four cognitive enhancer dosage indicators and delirium diagnosis (HR: 1.617, 95% CI: 1.295–2.018), were statistically significant. Mental health outcomes, including depression diagnosis (HR: 1.223, 95% CI: 1.061–1.410), and physical health outcomes, such as all-cause mortality (HR: 1.297, 95% CI: 1.215–1.384) and CVD diagnosis (HR: 1.334, 95% CI: 1.160–1.533), also reached statistical significance. Femur fracture (HR: 0.999, 95% CI: 0.863–1.156) showed no statistical significance, serving as a control outcome.

The results of the sensitivity analysis using an alternative control group (Group 5, with an LTCI score of 45-50) are shown in **Supplementary Table 3**. This analysis included 2,028 CAG beneficiaries and 2,028 LTCI Grade 5 beneficiaries. No statistically significant difference in cognitive decline was observed between the two groups (HR: 1.056, 95% CI: 0.902–1.236). However, among CAG beneficiaries, there was a significant increase in the risk of dementia progression, as measured by cognitive enhancer dosage and depression diagnosis (HR: 1.840, 95% CI: 1.337–2.533), compared to Grade 5 beneficiaries. Additionally, CAG beneficiaries were less likely to experience physical and mental dependency (HR: 0.615, 95% CI: 0.491–0.771).

Supplementary Table 4 illustrates a dose-dependent relationship between frequency of LTC service utilization among CAG and Grade 5 beneficiaries. The reference group consisted of LTCI Grade 5 beneficiaries who did not use any LTC services. Compared to this reference, no statistically significant differences were observed across varying levels of LTC service use for both CAG and Grade 5 groups. In the Grade 5 group, no significant dose-dependent trend was found (p-for-trend: 0.3153), while in CAG beneficiaries, a marginally significant dose-dependent decrease in cognitive decline was observed as LTC service utilization frequency increased (p-for-trend: 0.0609).
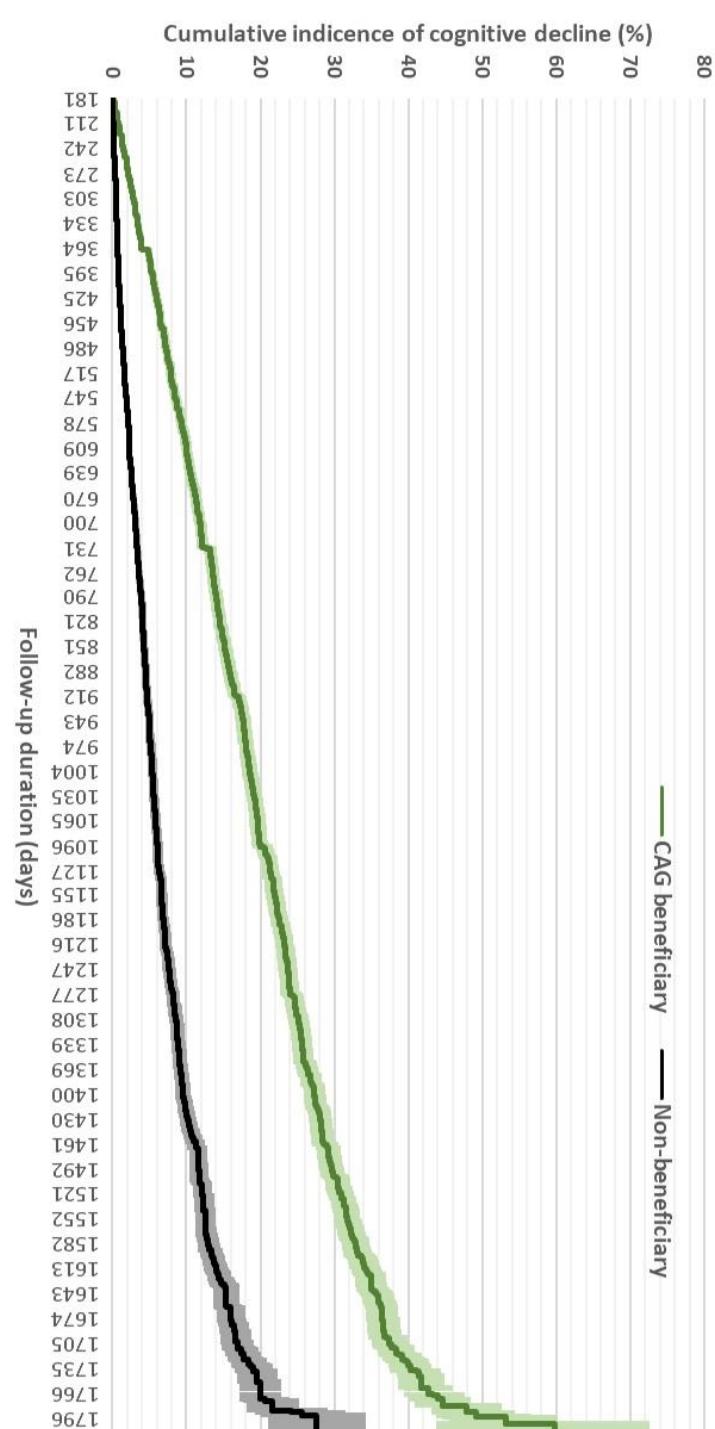
Figure 3. Kaplan-Meier Curve of the Cumulative Incidence of Cognitive Decline Between Cognitive Assistance Grade Beneficiaries and Matched Controls ($p < 0.0001$, log-rank test)

Abbreviation: CAG; Cognitive Assistance Grade

4.3. The association between long-term care service utilization and cognitive decline among Cognitive Assistance Grade beneficiaries

Table 9 presents dose-dependent analyses of LTC service utilization frequency among CAG beneficiaries over a six-month period. Utilizing LTC services More than 20 times/month exhibited a significantly reduced risk of cognitive decline compared to no utilization of LTC services (HR: 0.696, 95% CI: 0.598–0.809). Furthermore, a dose-response trend demonstrated that higher frequencies of LTC service use were associated with a progressively lower risk of cognitive decline (p-for-trend: <0.0001).

Compared to no utilization of LTC services, a significantly higher risk of increased cognitive enhancer dosage was observed, particularly among those utilizing LTC services More than 20 times/month, with a significant dose-dependent trend. Specifically, a statistically significant risk and dose-dependent trend were evident for the initial use or dosage increase of cognitive enhancers (HR: 1.124, 95% CI: 1.001–1.262, p-for-trend: 0.0371), initial use or dosage increase of memantine (HR: 1.272, 95% CI: 1.102–1.469, p-for-trend: 0.0009), maximum dosage administration of cognitive enhancers (HR: 1.180, 95% CI: 1.031–1.351, p-for-trend: 0.0087), and maximum dosage administration of memantine (HR: 1.439, 95% CI: 1.238–1.674, p-for-trend: <0.0001).

A significantly increased risk of delirium diagnosis was observed with LTC service utilization exceeding 20 times per month, following a dose-dependent trend (HR: 1.684, 95% CI: 1.070–2.651, p-for-trend: 0.0286). In contrast, a dose-dependent decrease in the risk of physical and mental dependency (LTCI Grades 1 or 2) was identified (p-for-trend: <0.0001). No significant trends were noted for the risks of depression, cardiovascular disease diagnoses, all-cause mortality, or femur fracture, the latter serving as a negative control.

Table 9. The association between long-term care service utilization and cognitive decline or other health outcomes

Variables	Hazard ratio				p-for-trend
	HR	95% CI			
Cognitive decline					
Frequency of LTC service utilization					
No LTC service	1.000				
Less than 10 times/month	1.054	0.772	-	1.440	<0.0001
10-20 times/month	0.879	0.632	-	1.223	
More than 20 times/month	0.696	0.598	-	0.809	
Initial use or dosage increase of cognitive enhancers					
Frequency of LTC service utilization					
No LTC service	1.000				
Less than 10 times/month	1.301	1.022	-	1.656	0.0371
10-20 times/month	1.242	0.973	-	1.586	
More than 20 times/month	1.124	1.001	-	1.262	
Initial use or dosage increase of memantine					
Frequency of LTC service utilization					
No LTC service	1.000				
Less than 10 times/month	1.456	1.078	-	1.966	0.0009
10-20 times/month	1.306	0.959	-	1.779	
More than 20 times/month	1.272	1.102	-	1.469	
Maximum dosage administration of cognitive enhancers					
Frequency of LTC service utilization					
No LTC service	1.000				
Less than 10 times/month	1.742	1.347	-	2.252	0.0087
10-20 times/month	1.676	1.298	-	2.163	
More than 20 times/month	1.180	1.031		1.351	
Maximum dosage administration of memantine					
Frequency of LTC service utilization					
No LTC service	1.000				
Less than 10 times/month	1.552	1.129	-	2.133	<.0001
10-20 times/month	1.786	1.333	-	2.393	
More than 20 times/month	1.439	1.238	-	1.674	
Delirium diagnosis					
Frequency of LTC service utilization					
No LTC service	1.000		-		
Less than 10 times/month	1.422	0.504	-	4.014	0.0286
10-20 times/month	0.998	0.306	-	3.257	
More than 20 times/month	1.684	1.070		2.651	
Emergency room visit due to dementia					
Frequency of LTC service utilization					
No LTC service	1.000				0.5711
Less than 10 times/month	2.917	0.619	-	13.740	

	HR	95% CI			P-value
10-20 times/month	2.737	0.581	-	12.894	
More than 20 times/month	1.291	0.484	-	3.440	
Physical/mental dependency (Grade 1 or 2)					
Frequency of LTC service utilization					
No LTC service	1.000				
Less than 10 times/month	1.558	1.026	-	2.367	<0.0001
10-20 times/month	1.055	0.650	-	1.712	
More than 20 times/month	0.521	0.399	-	0.681	
Depression diagnosis					
Frequency of LTC service utilization					
No LTC service	1.000				
Less than 10 times/month	1.407	0.704	-	2.811	0.6811
10-20 times/month	1.773	0.965	-	3.259	
More than 20 times/month	1.046	0.745	-	1.470	
All-cause mortality					
Frequency of LTC service utilization					
No LTC service	1.000				
Less than 10 times/month	1.732	1.356	-	2.211	0.0627
10-20 times/month	1.140	0.856	-	1.517	
More than 20 times/month	0.885	0.772	-	1.014	
Cardiovascular or cerebrovascular disease					
Frequency of LTC service utilization					
No LTC service	1.000				
Less than 10 times/month	1.291	0.693	-	2.408	0.8164
10-20 times/month	1.668	0.969	-	2.871	
More than 20 times/month	1.011	0.751	-	1.360	
Femur fracture diagnosis					
Frequency of LTC service utilization					
No LTC service	1.000				
Less than 10 times/month	0.451	0.142	-	1.429	0.6636
10-20 times/month	1.285	0.644	-	2.563	
More than 20 times/month	1.052	0.754	-	1.468	

Abbreviation: HR; hazard ratio, CI; confidence interval, LTC; long-term care

4.4. Subgroup analyses based on dementia patient and institutional characteristics

Subgroup analyses stratified by the presence of cognitive symptoms or behavioral problems at the index date (**Table 10**) revealed that dementia patients with mildly impaired cognitive function had a significantly lower risk of cognitive decline with LTC service utilization exceeding 20 times per month compared to no utilization, following a dose-dependent decreasing trend (HR: 0.732, 95% CI: 0.617–0.869, p-for-trend: 0.0069). Similar findings were observed among dementia patients without behavioral symptoms (HR: 0.669, 95% CI: 0.568–0.788, p-for-trend: <0.0001).

Table 10. Subgroup analyses based on cognitive or behavioral dementia symptoms

Variables	Hazard ratio				p-for-trend
	HR		95% CI		
Mildly impaired cognitive function					
Cognitive decline					
Frequency of LTC service utilization					
No LTC service	1.000				
Less than 10 times/month	1.188	0.845	-	1.670	0.0006
10-20 times/month	1.077	0.763	-	1.522	
More than 20 times/month	0.732	0.617	-	0.869	
Significantly impaired cognitive function					
Cognitive decline					
Frequency of LTC service utilization					
No LTC service	1.000				
Less than 10 times/month	0.841	0.388	-	1.820	0.1464
10-20 times/month	0.346	0.109	-	1.094	
More than 20 times/month	0.785	0.565	-	1.092	
Without behavior problem					
Cognitive decline					
Frequency of LTC service utilization					
No LTC service	1.000				
Less than 10 times/month	1.049	0.750	-	1.468	<.0001
10-20 times/month	0.838	0.585	-	1.201	
More than 20 times/month	0.669	0.568	-	0.788	
With behavior problem					
Cognitive decline					
Frequency of LTC service utilization					
No LTC service	1.000				
Less than 10 times/month	1.090	0.471	-	2.522	0.5545
10-20 times/month	1.178	0.507	-	2.740	
More than 20 times/month	0.882	0.593	-	1.311	

Abbreviation: HR; hazard ratio, CI; confidence interval, LTC; long-term care, n.a; not applicable

Subgroup analyses based on dementia patient characteristics—including age group, sex, dementia severity (measured by cumulative cognitive enhancer dosage), and the impact of the COVID-19 pandemic (2020 cutoff)—are summarized in **Table 11**. The results were largely consistent with the main findings, demonstrating that LTC service utilization exceeding 20 times per month was linked with a lower likelihood of cognitive decline compared to non-utilization, with a dose-dependent reduction in risk observed with increased frequency of LTC service use.

Participants under 85 years old exhibited a significant dose-dependent reduction in the risk of cognitive decline with increased LTC service utilization, whereas no significant trend was observed among those older than 85 years (p-for-trend: 0.0190 for participants under 75 years, p-for-trend: 0.0001 for ages 75–85, and p-for-trend: 0.0956 for those over 85 years). Dementia patients across all sexes and severity levels also demonstrated a dose-dependent decrease in cognitive decline risk. This pattern of gradual risk reduction was evident in Alzheimer's disease (p-for-trend: <0.0001) but not in other types of dementia.

Table 11. Subgroup analyses based on characteristics of dementia patients

Variables	Hazard ratio				p-for-trend
	HR	95% CI			
Aged less than 75 years					
Cognitive decline					
Frequency of LTC service utilization					
No LTC service	1.000				
Less than 10 times/month	0.795	0.390	-	1.622	0.0190
10-20 times/month	1.079	0.599	-	1.944	
More than 20 times/month	0.705	0.528	-	0.942	
Aged 75-85					
Cognitive decline					
Frequency of LTC service utilization					
No LTC service	1.000				
Less than 10 times/month	0.991	0.669	-	1.467	0.0001
10-20 times/month	0.843	0.557	-	1.277	
More than 20 times/month	0.692	0.573	-	0.835	
Aged more than 85 years					
Cognitive decline					
Frequency of LTC service utilization					
No LTC service	1.000				
Less than 10 times/month	2.212	1.012	-	4.838	0.0956
10-20 times/month	0.530	0.126	-	2.229	
More than 20 times/month	0.676	0.393	-	1.162	

Male					
Cognitive decline					
Frequency of LTC service utilization					
No LTC service	1.000				
Less than 10 times/month	1.103	0.625	-	1.947	0.0017
10-20 times/month	0.840	0.443	-	1.593	
More than 20 times/month	0.614	0.452	-	0.835	
Female					
Cognitive decline					
Frequency of LTC service utilization					
No LTC service	1.000				
Less than 10 times/month	1.035	0.713	-	1.503	0.0003
10-20 times/month	0.895	0.609	-	1.316	
More than 20 times/month	0.725	0.609	-	0.863	
Mild dementia severity					
Cognitive decline					
Frequency of LTC service utilization					
No LTC service	1.000				
Less than 10 times/month	0.827	0.361	-	1.895	0.0323
10-20 times/month	1.489	0.792	-	2.798	
More than 20 times/month	0.634	0.434	-	0.925	
Moderate dementia severity					
Cognitive decline					
Frequency of LTC service utilization					
No LTC service	1.000				
Less than 10 times/month	1.085	0.732	-	1.608	0.012
10-20 times/month	0.677	0.421	-	1.088	
More than 20 times/month	0.741	0.612	-	0.897	
Severe dementia severity					
Cognitive decline					
Frequency of LTC service utilization					
No LTC service	1.000				
Less than 10 times/month	1.172	0.613	-	2.241	0.0056
10-20 times/month	0.993	0.502	-	1.965	
More than 20 times/month	0.626	0.450	-	0.871	
Alzheimer's disease					
Cognitive decline					
Frequency of LTC service utilization					
No LTC service	1.000				
Less than 10 times/month	1.095	0.789	-	1.520	<0.0001
10-20 times/month	0.789	0.545	-	1.142	
More than 20 times/month	0.699	0.594	-	0.821	
Vascular dementia					
Cognitive decline					
Frequency of LTC service utilization					
No LTC service	1.000				
Less than 10 times/month	0.412	0.057	-	2.968	0.1247
10-20 times/month	1.347	0.417	-	4.354	

	HR	95% CI			p-value
More than 20 times/month	0.596	0.321	-	1.107	
Other types of dementia					
Cognitive decline					
Frequency of LTC service utilization					
No LTC service	1.000				
Less than 10 times/month	1.126	0.342	-	3.704	0.4674
10-20 times/month	1.753	0.674	-	4.554	
More than 20 times/month	0.770	0.428	-	1.386	
Before 2020					
Cognitive decline					
Frequency of LTC service utilization					
No LTC service	1.000				
Less than 10 times/month	1.113	0.705	-	1.756	0.0173
10-20 times/month	1.220	0.796	-	1.869	
More than 20 times/month	0.771	0.629	-	0.945	
After 2020					
Cognitive decline					
Frequency of LTC service utilization					
No LTC service	1.000				
Less than 10 times/month	0.969	0.633	-	1.485	<0.0001
10-20 times/month	0.590	0.350	-	0.995	
More than 20 times/month	0.616	0.491	-	0.772	

Abbreviation: HR; hazard ratio, CI; confidence interval, LTC; long-term care

4.5. Subgroup analyses categorized by the type of long-term care service

Subgroup analyses based on different types of LTC services, including Day and Night Care services and home-visit LTC services provided at the beneficiary's residence (e.g., home visit care, bathing, and nursing), are detailed in **Table 12** and **Supplementary Table 5**. For Day and Night Care services alone, LTC utilization of fewer than 10 times per month was linked with a significantly higher risk of cognitive decline compared to non-utilization, but no dose-dependent trend was observed (HR: 1.591, 95% CI: 1.149–2.202, p-for-trend: 0.1887). In contrast, home-visit service utilization showed a significant decrease in cognitive decline risk across all frequency levels, with a significant dose-dependent trend (HR: 0.500, 95% CI: 0.295–0.847 for fewer than 10 times per month; HR: 0.564, 95% CI: 0.332–0.958 for 10–20 times per month; and HR: 0.501, 95% CI: 0.386–0.651 for More than 20 times/month; p-for-trend: <0.0001).

Table 12. Subgroup analyses based on different types of long-term care service utilization

Variables	Hazard ratio				p-for-trend
	HR	95% CI			
Only inclusion of Day and night care					
Cognitive decline					
Frequency of LTC service utilization					
No LTC service	1.000				
Less than 10 times/month	1.591	1.149	-	2.202	0.1887
10-20 times/month	1.336	0.930	-	1.919	
More than 20 times/month	0.872	0.740	-	1.027	
Only inclusion of home-visit nursing, bathing, and care					
Cognitive decline					
Frequency of LTC service utilization					
No LTC service	1.000				
Less than 10 times/month	0.500	0.295	-	0.847	<0.0001
10-20 times/month	0.564	0.332	-	0.958	
More than 20 times/month	0.501	0.386	-	0.651	

Abbreviation: HR; hazard ratio, CI; confidence interval, LTC; long-term care

Subgroup analyses categorized by the characteristics of LTC facilities utilized by LTCI beneficiaries during Day and Night Care services are presented in **Table 13** and **Supplementary Table 6**. Among participants utilizing Day and Night Care services in facilities with a staff-to-beneficiary ratio greater than 1.0, a significant decrease in the risk of cognitive decline was observed with utilization of Day and Night Care services More than 20 times/month, following a dose-dependent decreasing trend (HR: 0.655, 95% CI: 0.456–0.940, p-for-trend: 0.0311).

Table 13. Subgroup analyses based on the characteristics of long-term care facility

Variables	Hazard ratio				p-for-trend
	HR	95% CI			
Ratio of staff to beneficiaries less than 0.5					
Cognitive decline					
Frequency of LTC service utilization					
No LTC service	1.000				
Less than 10 times/month	1.745	1.225	-	2.486	0.2864
10-20 times/month	1.278	0.855	-	1.910	
More than 20 times/month	0.879	0.732	-	1.055	
Ratio of staff to beneficiaries 0.5-1.0					
Cognitive decline					
Frequency of LTC service utilization					
No LTC service	1.000				
Less than 10 times/month	0.722	0.180	-	2.897	0.0459
10-20 times/month	0.493	0.069	-	3.515	
More than 20 times/month	0.564	0.309	-	1.029	
Ratio of staff to beneficiaries more than 1.0					
Cognitive decline					
Frequency of LTC service utilization					
No LTC service	1.000				
Less than 10 times/month	0.838	0.313	-	2.244	0.0311
10-20 times/month	1.448	0.600	-	3.497	
More than 20 times/month	0.655	0.456	-	0.940	
Variables	Hazard ratio				p-for-trend
	HR	95% CI			
LTC facilities with fewer than 10 staff members					
Cognitive decline					
Frequency of LTC service utilization					
No LTC service	1.000				
Less than 10 times/month	1.263	0.755	-	2.113	0.1549
10-20 times/month	1.663	1.049	-	2.635	
More than 20 times/month	0.803	0.640	-	1.007	
LTC facilities with 10 to 30 staff members					
Cognitive decline					

Frequency of LTC service utilization					
No LTC service	1.000				
Less than 10 times/month	1.493	0.932	-	2.392	0.1445
10-20 times/month	0.915	0.491	-	1.707	
More than 20 times/month	0.841	0.674	-	1.049	

LTC facilities with more than 30 staff members

Cognitive decline

Frequency of LTC service utilization					
No LTC service	1.000				
Less than 10 times/month	2.213	1.246	-	3.929	0.5060
10-20 times/month	1.273	0.567	-	2.858	
More than 20 times/month	0.867	0.652	-	1.154	

Variables	Hazard ratio				**p-for-trend**
	HR	95% CI			

LTC facility capacity less than 30

Cognitive decline

Frequency of LTC service utilization					
No LTC service	1.000				
Less than 10 times/month	1.369	0.916	-	2.047	0.0700
10-20 times/month	1.291	0.857	-	1.946	
More than 20 times/month	0.811	0.669	-	0.984	

LTC facility capacity 30-60

Cognitive decline

Frequency of LTC service utilization					
No LTC service	1.000				
Less than 10 times/month	1.903	1.098	-	3.298	0.3486
10-20 times/month	1.306	0.649	-	2.626	
More than 20 times/month	0.854	0.662	-	1.101	

LTC facility capacity more than 60

Cognitive decline

Frequency of LTC service utilization					
No LTC service	1.000				
Less than 10 times/month	1.128	0.467	-	2.725	0.1006
10-20 times/month	1.065	0.342	-	3.311	
More than 20 times/month	0.732	0.512	-	1.047	

Abbreviation: HR; hazard ratio, CI; confidence interval, LTC; long-term care

4.6. Sensitivity analyses based on alternative intervals for long-term care service utilization and alternative criteria for cognitive decline

Sensitivity analyses using alternative intervals for the accumulation of LTC service utilization and outcome occurrence, rather than the standard six-month accumulation and three-month outcome period, are presented in **Table 14**. These analyses showed a significant decrease in the risk of cognitive decline with LTC utilization exceeding 20 times per month, consistent with the main outcomes, demonstrating a dose-dependent reduction in risk with increased LTC utilization.

Table 15 presents results based on alternative benchmarks for cognitive decline, defined by increases in cognitive domain scores by 1, 2, 4, or 5 points out of 7, instead of the standard 3-point benchmark. The findings were generally consistent with the main outcomes across all alternative thresholds.

Table 14. Sensitivity analyses based on alternative intervals for utilization and outcome

Variables	Hazard ratio				p-for-trend
	HR	95% CI			
One-year for cumulation and three-month for outcome					
Cognitive decline					
Frequency of LTC service utilization					
No LTC service	1.000				
Less than 10 times/month	0.834	0.509	-	1.364	<0.0001
10-20 times/month	0.832	0.475	-	1.456	
More than 20 times/month	0.611	0.494	-	0.757	
Three-month for cumulation and three-month for outcome					
Cognitive decline					
Frequency of LTC service utilization					
No LTC service	1.000				
Less than 10 times/month	0.966	0.775	-	1.205	<0.0001
10-20 times/month	0.839	0.717	-	0.982	
More than 20 times/month	0.688	0.601	-	0.789	
Six-month for cumulation and six-month for outcome					
Cognitive decline					
Frequency of LTC service utilization					
No LTC service	1.000				
Less than 10 times/month	0.954	0.744	-	1.222	<0.0001
10-20 times/month	0.824	0.636	-	1.068	
More than 20 times/month	0.737	0.659	-	0.825	

Abbreviation: HR; hazard ratio, CI; confidence interval, LTC; long-term care

Table 15. Sensitivity analyses based on alternative criteria for cognitive decline

Variables	Hazard ratio				p-for-trend
	HR	95% CI			
Increments of 1 out of 7 points					
Cognitive decline					
Frequency of LTC service utilization					
No LTC service	1.000				
Less than 10 times/month	1.182	0.996	-	1.404	0.0030
10-20 times/month	1.026	0.854	-	1.233	
More than 20 times/month	1.123	1.042	-	1.210	
Increments of 2 out of 7 points					
Cognitive decline					
Frequency of LTC service utilization					
No LTC service	1.000				
Less than 10 times/month	1.122	0.905	-	1.392	0.1033
10-20 times/month	0.928	0.735	-	1.170	
More than 20 times/month	0.924	0.837	-	1.020	
Increments of 4 out of 7 points					
Cognitive decline					
Frequency of LTC service utilization					
No LTC service	1.000				
Less than 10 times/month	1.226	0.783	-	1.921	0.0001
10-20 times/month	0.717	0.409	-	1.256	
More than 20 times/month	0.638	0.502	-	0.810	
Increments of 5 out of 7 points					
Cognitive decline					
Frequency of LTC service utilization					
No LTC service	1.000				
Less than 10 times/month	1.223	0.638	-	2.344	0.0761
10-20 times/month	0.689	0.302	-	1.571	
More than 20 times/month	0.757	0.546	-	1.049	

Abbreviation: HR; hazard ratio, CI; confidence interval, LTC; long-term care

V. Discussion

5.1. Results discussion

This study found out the linkage between the expansion of LTCI for dementia patients and the progression of dementia, as well as its impact on other mental and physical health outcomes. Dose-dependent analyses revealed a lower likelihood of cognitive decline among individuals utilizing LTC services More than 20 times/month, with a consistent dose-dependent reduction in risk as service utilization increased. Conversely, an increased risk of cognitive enhancer dosage escalation, maximum dosage administration, and delirium was observed, following a dose-dependent trend. These dose-dependent patterns were generally consistent across subgroup analyses. Meanwhile, when compared to LTCI non-beneficiaries, CAG beneficiaries exhibited a higher risk of dementia progression, including cognitive decline.

Several mechanisms may explain the dose-dependent decrease trend of cognitive decline. A dose-dependent decrease in cognitive decline was observed with increased frequency of LTC service use, suggesting that LTC services could help slow dementia progression and reduce all-cause mortality. CAG beneficiaries had access to a range of LTC services, including activities to support daily living, creativity, memory, physical ability, sensory engagement, and cognitive function—all tailored to assist older adults with dementia[56]. Previous research has demonstrated the effectiveness of such interventions; for example, the introduction of cognitive training programs for LTCI beneficiaries in Korea in 2014 led to significantly less cognitive decline compared to non-beneficiaries[54]. Additionally, CAG beneficiaries are likely to experience benefits from greater social participation and enhanced access to dementia-related information through interactions with other beneficiaries in Day and Night Care facilities. This exposure, in the context of the TPB, can foster favorable attitudes, enhance understanding of dementia management, and support physical health maintenance, thereby contributing to improved overall health outcomes. Additionally, the effectiveness of social participation in reducing the risk of dementia is well-documented[70,71].

CAG beneficiaries who utilized LTC services were more likely to engage in proactive dementia management behaviors. Such proactive behaviors often extend to applying for LTCI, which requires an eligibility assessment by the NHI, leading to periodic reassessments and updates on dementia status. This proactive approach may be driven more by caregivers than the beneficiaries themselves. Given the common tendency of dementia patients to disregard or deny their diagnosis—a factor

contributing to the high rates of underdiagnosis—caregivers may seek higher LTCI grades to access more comprehensive services with reduced out-of-pocket expenses, especially in difficult occupational or financial situations[72,73]. A reverse association is also possible, wherein patients with less advanced dementia might be more likely to utilize LTC benefits more frequently. However, the inconsistent trends observed in the risk of delirium and emergency room visits suggest that more frequent LTC service utilization is linked with a decreased risk of cognitive decline.

The dose-dependent trends in cognitive decline reduction were especially notable among individuals under 85 years of age or with mildly impaired cognitive function or without behavioral symptoms, suggesting that early LTC intervention for dementia patients may be more effective. This trend persisted in home-visit LTC services, including nursing, bathing, and care, and showed marginal significance in Day and Night Care services. These differences may stem from the personalized, patient-centered approach of home-visit LTC services compared to the more group-based approach of Day and Night Care. Home-based interventions that incorporate individualized exercise programs and environmental modifications—such as hazard removal and adaptive equipment installation—have been shown to help prevent functional decline in physically frail older adults[74]. The importance of patient-tailored LTC interventions is further underscored by the significant dose-dependent decrease in cognitive decline observed exclusively among dementia patients who used facilities with a staff-to-beneficiary ratio greater than 1.0 or with more than 30 staff members.

The more frequent older adults with dementia utilize LTC service, the higher cognitive dosage risk was. However, these trends had disappeared in dementia patients focusing on home-visit LTC services (Day and Night Care services were not included) utilization. In facility, there would be more likely interpersonal interaction among LTCI beneficiaries, compared to home-visit LTC service. Based on TPB, this interaction could fertilize favorable intention to using cognitive enhancers. Also, it is possible that it is proactive or impossible to care for their patients' caregivers would be more likely to provide management to their patients. This intention may be neither effective nor appropriate for dementia management, as the dose-dependent decrease in the risk of cognitive decline showed only marginal significance (p-for-trend: 0.0589). This is further supported by the sustained dose-dependent increase observed among dementia patients using facilities with a staff-to-beneficiary ratio below 0.5, smaller capacity, or fewer staff members. In comparisons between CAG and Grade 5 beneficiaries who started with similar cognitive function domain scores and

cognitive enhancer dosages, CAG beneficiaries were more likely to increase their enhancer dosage, and this result would support the ineffectiveness of increasing dosage of cognitive enhancers.

The comparison between CAG beneficiaries and LTCI non-beneficiaries with dementia diagnoses indicates that CAG beneficiaries likely had more severe baseline dementia and overall poorer health status. This suggests that CAG beneficiaries were more likely to exhibit symptoms or have needs requiring LTC services compared to non-beneficiaries. This is supported by significantly higher risks observed across all dementia progression indicators, including cognitive decline and delirium diagnosis. Significant findings in all-cause mortality, depression diagnosis, physical or mental dependency, and CVD diagnosis further indicate marked health differences between CAG beneficiaries and non-beneficiaries, despite the latter's eligibility for CAG registration. Femur fractures, included as a control outcome unrelated to dementia, showed no significant association in this study. In contrast, differences in dementia progression risk between CAG beneficiaries and LTCI Grade 5 beneficiaries were minimal. Overall, the dementia profiles of CAG beneficiaries align more closely with those of LTCI Grade 5 beneficiaries than with non-beneficiaries with dementia. Additional research is required to explore the characteristics, health conditions, and reasons behind the lack of LTCI applications among eligible non-beneficiaries.

5.2. Method discussion

A retrospective observational design was chosen due to the impracticality of conducting a prospective study, as the LTCI expansion was implemented nationwide, making it ethically challenging to exclude eligible beneficiaries. Retrospective designs offer several advantages, including the ability to identify all eligible cases and controls efficiently and the feasibility of studying dementia progression, particularly in patients with severe dementia who are otherwise difficult to research.

An individual-level approach was adopted instead of an aggregated population-level approach to provide a more detailed and precise assessment of the effects of LTCI expansion and LTC service utilization. Additionally, since the 2018 LTCI expansion was applied universally to the dementia population in Korea, selecting a control group for the expansion was not feasible, further justifying the use of an individual-level design.

5.3. Strengths and limitations

This study has key strengths, being the first to evaluate the risk of dementia progression and other physical and mental health outcomes linked to the expansion of LTCI to universal coverage for dementia patients. Research on the impact of LTCI expansion on health outcomes has been limited, making this study particularly relevant for future LTCI policy planning. The study utilized data from half of all dementia patients in Korea and employed robust, prospectively collected prescription-based data. The gigantic sample size including half of all dementia patients and retrospective design allowed for the identification of associations between insurance coverage changes and health outcomes among all eligible participants, which would be challenging to achieve through RCTs due to ethical concerns and selection bias.

However, the study also has several limitations. The lack of cohort data prevented analysis of essential health-related variables, including dementia severity. Although proxy indicators were used, these variables may not directly reflect the cognitive function. Repeated neuropsychological test results would be necessary to establish clearer associations and causality. Additionally, detailed LTC interventions during Day and Night Care services were lacking. The self-reported nature of several covariates, including physical exercise, smoking status, and alcohol consumption may introduce inaccuracies. Moreover, these covariates were collected during biannual screening tests, which may not accurately reflect participant characteristics at the exact index date. Despite rigorous inclusion criteria for dementia, the potential for misdiagnosis and fraudulent claims among LTCI beneficiaries cannot be eliminated. While significant efforts were made to match variables such as dementia severity, diagnosis dates, and proxy indicators of health-related behaviors (including the availability of health screening results), it is feasible that CAG beneficiaries were more prone to reassessment of their LTC scores or to more actively manage their dementia condition. This active management could potentially result in an apparent increase in dementia severity as indicated by these proxy markers. Moreover, an inverse association between the frequency of LTC service utilization and the severity of health problems would be possible; more frequent users of LTC services tended to be healthier. This could reflect a scenario where higher engagement with LTC services, possibly due to better overall health or more proactive health management, leads to better health outcomes. Finally, as the study focused exclusively on registered Korean individuals, further research is required to assess the generalizability to other populations.

5.4. Policy implications

The results suggest that expanding LTCI coverage to encompass a broader range of senile diseases beyond dementia could be beneficial. Although non-beneficiaries typically displayed milder forms of dementia, the use of LTC services has shown effectiveness in slowing cognitive decline and supporting physical health, making it advantageous for this group as well. Early intervention with LTC services may also be more effective, as the benefits of LTC service utilization were generally maintained among relatively younger older adults and those with early stage of dementia. Additionally, no significant dose-dependent decrease trend based on LTC service utilization was observed in Grade 5 beneficiaries, who typically had more severe dementia compared to CAG beneficiaries, supporting the potential advantage of earlier LTC intervention. Moreover, from the perspective of LTCI facilities, a higher ratio of LTC workers to beneficiaries and patient-tailored interventions are essential. Improvements in offline facilities and program offerings within LTC services are also needed to enhance the quality of care.

Despite the expansion of LTCI coverage to all older adults with dementia in January 2018, a substantial number did not enroll, possibly due to limited awareness of LTC services' benefits and available financial support. Furthermore, non-beneficiaries with dementia appeared less likely to have their LTCI scores reassessed and were generally less proactive in managing cognitive decline and other dementia-related symptoms. To address this, initiatives such as extensive public awareness campaigns or automatic enrollment could be implemented to emphasize the importance of regular health monitoring, reassessment, and active management. These strategies should be considered alongside universal LTCI coverage to promote broader and more effective utilization. Given the potential differences in baseline characteristics between CAG beneficiaries and non-beneficiaries, alternative interventions or grouping strategies may be necessary for the current non-beneficiaries.

Nevertheless, the cost-effectiveness of expanding LTCI coverage requires careful consideration. Between 2018 and 2022, the financial budget for home-care services increased by 106.5%, and for Day and Night Care services by 142.3% (with a 51.7% increase for institutional care services and an 81.7% increase in total LTCI funding), while citizens' contribution rates rose by 75.5% over the same period. Additionally, the dementia prevalence among Koreans is projected to reach 22.3%, further straining LTCI finances. Introducing universal coverage could place a substantial financial burden on both citizens and the government. Further research is essential to evaluate LTCI budget allocations relative to the potential savings and social benefits of universal coverage.

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Supplementary materials

Supplementary Table 1. ICD-10 codes or Korea Major Ingredient Codes were utilized in the analyses

Variables	ICD-10 code (diagnosis) or Korea major ingredient code (medication)
Dementia	F00, F01, F02, F03, G30
Secondary outcomes	
Delirium	F05
Depression	F32, F33
Femur fracture	S72
Comorbidity	
Acute myocardial infarction	I21, I252
Congestive heart failure	I50
Cerebral vascular disease	I60, I61, I62, I63, I64, I69
Peripheral vascular disease	I702, I73
Chronic pulmonary disease	J42, J43, J44, J45, J46, J47, J60, J61, J62, J63, J64, J65, J66, J67, J701, J703
Connective tissue disease	M05, M06, M30, M31, M32, M33, M34, M35, M36, M45
Peptic ulcer	K25, K26, K27, K28
Mild liver disease	B18, K704, K711, K7131, K714, K715, K73, Z944
Severe liver disease	K703, K717, K721, K729, K743, K744, K745, K746, I85, I864, I982
Diabetes without chronic complication	E100, E101, E106, E108, E109, E110, E111, E116, E118, E119, E120, E121, E126, E128, E129, E130, E131, E136, E138, E139, E140, E141, E146, E148, E149
Diabetes with chronic complication	E102, E103, E104, E105, E107, E112, E113, E114, E115, E117, E122, E123, E124, E125, E127, E132, E133, E134, E135, E137, E142, E143, E144, E145, E147
Hemiplegia	G041, G114, G801, G81, G82, G830, G831, G832, G833, G834 G839
Chronic renal disease	N18, Z940, Z491, Z492, Z992, T861
Cancer without metastasis	C00,C01,C02,C03,C04,C05,C06,C07,C08,C09,C10,C11,C12,C13,C14,C15,C16,C17,C18,C19,C20,C21,C22,C23,C24,C25,C26,C30,C31,C32,C33,C34,C37,C38,C39,C40,C41,C43,C45,C46,C47,C48,C49,C50,C51,C52,C53,C54,C55,C56,C57,C58,C60,C61,C62,C63,C64,C65,C66,C67,C68,C69,C70,C71,C72,C73,C74,C75,C76,C81,C82,C83,C84,C85,C88,C90,C91,C92,C93,C94,C95,C96,C97
Metastatic carcinoma	C77, C78, C79, C80
AIDS	B20, B21, B22, B24
Cognitive enhancer	
Donepezil	148601ATB, 148601ATD, 148602ATB, 148602ATD, 148603ATB, 643401ATD, 643402ATD
Rivastigmine	224506CPC, 224507CPC, 224508CPC, 224501ACH, 224503ACH, 224504ACH, 224505ACH
Galantamine	385203ACR, 385203ATR, 385204ACR, 385204ATR, 385205ACR, 385205ATR
Memantine	190031ALQ, 190001ATB, 190003ATD, 190004ATB, 190004ATD
Selective serotonin reuptake inhibitor	
Fluoxetine	161501ACH, 161501ATB, 161502ACH, 161502ATB, 161502ATD
Paroxetine	209301ATB, 209302ATB, 209304ATB, 209305ATB,
Sertraline	227001ATB, 227002ATB, 227003ATB
Escitalopram	474801ATB, 474802ATB, 474803ATB, 474804ATB
Vortioxetine	628501ATB, 628502ATB, 628503ATB
Fluvoxamine	162501ATB, 162502ATB
Citalopram	428301ATB
Selective norepinephrine reuptake inhibitor	
Venlafaxine	247502ACR, 247504ACR
Desvenlafaxine	626401ATR, 626402ATR
Duloxetine	495501ACE, 495501ATE, 495502ACE, 495502ATE

Milnacipran	355801ACH, 355802ACH, 355803ACH
Mirtazapine	196201ATB, 196201ATD, 196202ATB, 196202ATD, 196204ATB, 196204ATD,
Trazodone	242901ACH, 242901ATB, 242902ATB, 242903ATB
Bupropion	428101ATB, 428102ATB, 428103ATB
Tianeptine sodium	229601ATB
Agomelatine	613101ATB
Antipsychotics	
Haloperidol	167903ATB, 167904ATB, 167905ATB, 167906ATB, 167908ATB, 167930BIJ, 168030BIJ
Risperidone	224201ATB, 224201ATD, 224202ATB, 224202ATD, 224203ATB, 224204ATB, 224204ATD, 224205BIJ, 224206BIJ
Olanzapine	204001ATB, 204001ATD, 204002ATB, 204002ATD, 204004ATB, 204005ATB, 204001BIJ
Quetiapine	378601ATB, 378602ATB, 378603ATB, 378606ATR, 378604ATB, 378607ATR, 378605ATB, 378605ATR, 378608ATR, 378609ATR, 378610ATR
Ziprasidone	464901ACH, 464902ACH, 464903ACH, 464904ACH
Aripiprazole	451501ATB, 451501ATD, 451502ATB, 451502ATD, 451503ATB, 451505ATB, 451505ATB, 451508ATB, 451506BIJ, 451507BIJ
Paliperidone	503201ATR, 503202ATR, 503203ATR, 586430BIJ, 586431BIJ, 586432BIJ, 586433BIJ, 586434BIJ, 586435BIJ, 586436BIJ, 586437BIJ, 586438BIJ, 586439BIJ, 586440BIJ
Clozapine	137501ATB, 137502ATB, 137503ATB, 137504ATB
Amisulpride	420002ATB, 420003ATB, 420004ATB
Blonanserin	511301ATB, 511302ATB, 511303ATB
Zotepine	250801ATB, 250802ATB, 250803ATB

Abbreviation: ICD-10; International Statistical Classification of Diseases and Related Health Problems 10th Revision, AIDS; Acquired Immune Deficiency Syndrome

Supplementary Table 2. The association between being a Cognitive Assistance Grade beneficiary and cognitive decline and other health outcomes

Variables	Number of subjects	Number of events	Incidence rate per 1,000 person-year				Hazard ratio			
	n	n	IR	95% CI			HR	95% CI		
Cognitive decline										
Matched controls	8511	469	23.32	21.34	-	25.48	1.000			
CAG beneficiaries	8511	1453	75.88	72.22	-	79.72	3.329	3.000	-	3.695
Initial use or dosage increase of cognitive enhancers										
Matched controls	8511	2775	175.41	168.68	-	182.40	1.000			
CAG beneficiaries	8511	3628	252.65	244.21	-	261.39	1.410	1.342	-	1.481
Initial use or dosage increase of memantine										
Matched controls	8511	1165	61.92	58.48	-	65.56	1.000			
CAG beneficiaries	8511	1916	109.28	104.54	-	114.24	1.771	1.647	-	1.905
Maximum dosage administration of cognitive enhancers										
Matched controls	8511	1420	76.98	73.11	-	81.06	1.000			
CAG beneficiaries	8511	2227	130.44	125.20	-	135.89	1.704	1.594	-	1.821
Maximum dosage administration of memantine										
Matched controls	8511	908	47.18	44.23		50.31	1.000			
CAG beneficiaries	8511	1560	86.00	81.90	-	90.30	1.84	1.695	-	1.996
Delirium diagnosis										
Matched controls	8511	127	6.26	5.26	-	7.45	1.000			
CAG beneficiaries	8511	203	10.11	8.81	-	11.60	1.617	1.295	-	2.018
Emergency room visit due to dementia										
Matched controls	8511	37	1.82	1.32	-	2.51	1.000			
CAG beneficiaries	8511	48	2.37	1.78	-	3.14	1.302	0.848	-	1.999
Physical/mental dependency (Grade 1 or 2)										
Matched controls	8511	296	14.60	13.05	-	16.33	1.000			
CAG beneficiaries	8511	606	30.24	27.99	-	32.67	2.105	1.832	-	2.419
Depression diagnosis										
Matched controls	8511	348	17.65	15.88	-	19.63	1.000			
CAG beneficiaries	8511	423	21.70	19.71	-	23.89	1.223	1.061	-	1.410
All-cause mortality										
Matched controls	8511	1613	78.92	75.41	-	82.59	1.000			
CAG beneficiaries	8511	2069	101.64	97.77	-	105.67	1.297	1.215	-	1.384
Cardiovascular or cerebrovascular disease										
Matched controls	8511	348	17.46	15.72	-	19.40	1.000			
CAG beneficiaries	8511	458	23.32	21.27	-	25.57	1.334	1.16	-	1.533
Femur fracture										
Matched controls	8511	358	18.01	16.23	-	19.98	1.000			
CAG beneficiaries	8511	357	18.00	16.22	-	19.96	0.999	0.863	-	1.156

Abbreviation: IR; incidence ratio, CI; confidence interval, HR; hazard ratio, CAG; cognitive assistance grade

Supplementary Table 3. The association between being a Cognitive Assistance Grade beneficiary and cognitive decline and other health outcomes compared to Grade 5 beneficiaries

Variables	Number of subjects	Number of events	Incidence rate per 1,000 person-year				Hazard ratio			
	n	n	IR	95% CI			HR	95% CI		
Cognitive decline										
Matched controls (Grade 5)	1328	191	67.96	59.39	-	77.78				
CAG beneficiaries	1328	215	76.23	67.00	-	86.72	1.109	0.912	-	1.347
Initial use or dosage increase of cognitive enhancers										
Matched controls (Grade 5)	1328	455	206.57	187.86	-	227.13				
CAG beneficiaries	1328	564	268.50	245.85	-	293.23	1.3	1.149	-	1.471
Initial use or dosage increase of memantine										
Matched controls (Grade 5)	1328	247	90.78	80.05	-	102.95				
CAG beneficiaries	1328	276	109.50	97.54	-	122.93	1.206	1.016	-	1.433
Maximum dosage administration of cognitive enhancers										
Matched controls (Grade 5)	1328	191	107.16	95.40	-	120.38				
CAG beneficiaries	1328	212	131.37	118.14	-	146.08	1.228	1.046	-	1.440
Maximum dosage administration of memantine										
Matched controls (Grade 5)	1328	178	65.86	57.03	-	76.04				
CAG beneficiaries	1328	225	83.16	73.05	-	94.67	1.263	1.038	-	1.538
Delirium diagnosis										
Matched controls	1328	27	9.31	6.38	-	13.58				
CAG beneficiaries	1328	45	11.20	7.96	-	15.76	1.202	0.723	-	1.999
Emergency room visit due to dementia										
Matched controls (Grade 5)	1328	7	2.39	1.14	-	5.01				
CAG beneficiaries	1328	8	2.69	1.34	-	5.37	1.122	0.407	-	3.095
Physical/mental dependency (Grade 1 or 2)										
Matched controls (Grade 5)	1328	135	47.23	40.19	-	55.49	1.000			
CAG beneficiaries	1328	97	33.02	27.24	-	40.02	0.682	0.525	-	0.885
Depression diagnosis										
Matched controls (Grade 5)	1328	45	15.75	11.74	-	21.14				
CAG beneficiaries	1328	63	21.97	17.13	-	28.19	1.401	0.956	-	2.054
All-cause mortality										
Matched controls (Grade 5)	1328	331	112.80	102.32	-	124.36				

CAG beneficiaries	1328	303	101.38	91.56	-	112.26	0.885	0.757	-	1.034
Cardiovascular or cerebrovascular disease										
Matched controls (Grade 5)	1328	66	23.13	18.16	-	29.47				
CAG beneficiaries	1328	68	23.55	18.54	-	29.91	1.021	0.728	-	1.432
Femur fracture										
Matched controls (Grade 5)	1328	82	29.12	23.44	-	36.16				
CAG beneficiaries	1328	48	16.40	12.36	-	21.75	0.564	0.395	-	0.806

Abbreviation: IR; incidence ratio, CI; confidence interval, HR; hazard ratio, CAG; cognitive assistance grade

Supplementary Table 4. Dose-dependent analysis of frequency of long-term care service utilization between Cognitive Assistance Grade beneficiaries and Grade 5 beneficiaries

Variables	Hazard ratio				p-for-trend
	HR	95% CI			
Cognitive decline					
Matched controls (Grade 5)					
No LTC service	1.000				
Less than 10 times/month	0.872	0.456	-	1.667	0.3153
10-20 times/month	0.718	0.401	-	1.285	
More than 20 times/month	0.843	0.602	-	1.181	
CAG beneficiaries					
No LTC service	1.116	0.811	-	1.536	
Less than 10 times/month	1.051	0.597	-	1.850	0.0609
10-20 times/month	0.840	0.477	-	1.478	
More than 20 times/month	0.829	0.573	-	1.199	

Abbreviation: HR; hazard ratio, CI; confidence interval, CAG; cognitive assistance grade, LTCI; long-term care insurance, LTC; long-term care

Supplementary Table 5. Subgroup analyses based on different types of long-term care service utilization

Variables	Hazard ratio				p-for-trend
	HR	95% CI			
Only inclusion of Day and night care					
Initial use or dosage increase of cognitive enhancers					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	1.322	0.994	-	1.758	0.0017
10-20 times/month	1.393	1.038	-	1.869	
More than 20 times/month	1.196	1.058	-	1.354	
Initial use or dosage increase of memantine					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	1.324	0.916	-	1.913	0.0002
10-20 times/month	1.562	1.097	-	2.223	
More than 20 times/month	1.309	1.126	-	1.522	
Maximum dosage administration of cognitive enhancers					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	1.910	1.430	-	2.551	0.0005
10-20 times/month	1.957	1.457	-	2.628	
More than 20 times/month	1.227	1.065	-	1.414	
Maximum dosage administration of memantine					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	1.821	1.291	-	2.570	<0.0001
10-20 times/month	2.112	1.516	-	2.942	
More than 20 times/month	1.504	1.288	-	1.757	
Delirium diagnosis					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	0.910	0.221	-	3.740	0.1310
10-20 times/month	1.442	0.449	-	4.625	
More than 20 times/month	1.415	0.891	-	2.247	
Emergency room visit due to dementia					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	1.899	0.247	-	14.608	0.6885
10-20 times/month	4.008	0.896	-	17.920	
More than 20 times/month	1.054	0.371	-	2.993	
Physical/mental dependency (Grade 1 or 2)					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	2.335	1.534	-	3.556	<0.0001
10-20 times/month	1.016	0.539	-	1.915	
More than 20 times/month	0.383	0.269	-	0.543	
Depression diagnosis					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	1.177	0.479	-	2.893	0.2052
10-20 times/month	2.263	1.144	-	4.476	
More than 20 times/month	1.186	0.833	-	1.690	

All-cause mortality					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	1.535	1.146	-	2.055	<.0001
10-20 times/month	0.976	0.673	-	1.416	
More than 20 times/month	0.659	0.562	-	0.773	
Cardiovascular or cerebrovascular disease					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	1.196	0.559	-	2.558	0.9680
10-20 times/month	2.525	1.454	-	4.383	
More than 20 times/month	0.922	0.664	-	1.279	
Femur fracture					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	0.237	0.033	-	1.702	0.0848
10-20 times/month	1.264	0.514	-	3.108	
More than 20 times/month	1.349	0.960	-	1.896	
Only inclusion of home-visit nursing, bathing, and care					
Initial use or dosage increase of cognitive enhancers					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	1.039	0.759	-	1.421	0.3571
10-20 times/month	0.970	0.691	-	1.360	
More than 20 times/month	0.919	0.772	-	1.093	
Initial use or dosage increase of memantine					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	1.131	0.779	-	1.643	0.8687
10-20 times/month	0.826	0.524	-	1.305	
More than 20 times/month	0.998	0.815	-	1.221	
Maximum dosage administration of cognitive enhancers					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	1.363	0.992	-	1.873	0.6611
10-20 times/month	1.081	0.746	-	1.567	
More than 20 times/month	0.928	0.764	-	1.126	
Maximum dosage administration of memantine					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	0.947	0.618	-	1.450	0.7646
10-20 times/month	1.333	0.913	-	1.946	
More than 20 times/month	0.995	0.805	-	1.229	
Delirium diagnosis					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	2.069	0.831	-	5.150	0.1682
10-20 times/month	0.457	0.063	-	3.292	
More than 20 times/month	1.531	0.883	-	2.654	
Emergency room visit due to dementia					
Cumulative amount of LTC service					
No LTC service	n.a				n.a
Less than 10 times/month	n.a				

	HR	95% CI			p-value
10-20 times/month	n.a				
More than 20 times/month	n.a				
Physical/mental dependency (Grade 1 or 2)					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	0.821	0.406	-	1.662	0.7993
10-20 times/month	1.386	0.776	-	2.477	
More than 20 times/month	1.006	0.725	-	1.395	
Depression diagnosis					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	0.961	0.394	-	2.346	0.1567
10-20 times/month	0.631	0.201	-	1.980	
More than 20 times/month	0.712	0.423	-	1.196	
All-cause mortality					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	2.048	1.568	-	2.675	0.0001
10-20 times/month	1.500	1.083	-	2.077	
More than 20 times/month	1.295	1.094	-	1.534	
Cardiovascular or cerebrovascular disease					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	1.101	0.516	-	2.348	0.4125
10-20 times/month	0.710	0.263	-	1.915	
More than 20 times/month	1.215	0.836	-	1.768	
Femur fracture					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	1.201	0.530	-	2.723	0.1139
10-20 times/month	1.552	0.726	-	3.320	
More than 20 times/month	0.552	0.305	-	0.999	

Abbreviation: LTC; long-term care, HR; hazard ratio, CI; confidence interval, n.a; not applicable

Supplementary Table 6. Subgroup analyses based on the characteristics of long-term care facility

Variables	Hazard ratio				p-for-trend
	HR	95% CI			
Ratio of staff to beneficiaries less than 0.5					
Initial use or dosage increase of cognitive enhancers					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	1.531	1.117	-	2.098	0.0457
10-20 times/month	1.357	0.967	-	1.905	
More than 20 times/month	1.131	0.979	-	1.308	
Initial use or dosage increase of memantine					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	1.523	1.009	-	2.299	0.0006
10-20 times/month	1.496	0.990	-	2.260	
More than 20 times/month	1.330	1.116	-	1.585	
Maximum dosage administration of cognitive enhancers					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	2.035	1.462	-	2.833	0.0046
10-20 times/month	1.884	1.341	-	2.647	
More than 20 times/month	1.205	1.021	-	1.421	
Maximum dosage administration of memantine					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	1.965	1.319	-	2.927	<.0001
10-20 times/month	2.208	1.520	-	3.208	
More than 20 times/month	1.451	1.207	-	1.745	
Delirium diagnosis					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	0.741	0.101	-	5.410	0.0258
10-20 times/month	2.132	0.655	-	6.936	
More than 20 times/month	1.781	1.045	-	3.036	
Emergency room visit due to dementia					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	3.241	0.405	-	25.920	0.1667
10-20 times/month	6.215	1.319	-	29.289	
More than 20 times/month	1.772	0.579	-	5.419	
Physical/mental dependency (Grade 1 or 2)					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	2.380	1.468	-	3.861	<.0001
10-20 times/month	1.007	0.496	-	2.045	
More than 20 times/month	0.343	0.224	-	0.523	
Depression diagnosis					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	0.993	0.313	-	3.147	0.1943
10-20 times/month	1.287	0.472	-	3.510	
More than 20 times/month	1.294	0.868	-	1.928	
All-cause mortality					

Cumulative amount of LTC service						
No LTC service	1.000					
Less than 10 times/month	1.694	1.203	-	2.386		<.0001
10-20 times/month	1.022	0.667	-	1.565		
More than 20 times/month	0.672	0.555	-	0.814		

Cardiovascular or cerebrovascular disease

Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	0.958	0.353	-	2.599	0.9808
10-20 times/month	2.536	1.362	-	4.720	
More than 20 times/month	0.911	0.622	-	1.335	

Femur fracture

Cumulative amount of LTC service		
No LTC service	n.a	
Less than 10 times/month	n.a	
10-20 times/month	n.a	n.a
More than 20 times/month	n.a	

Variables	Hazard ratio			p-for-trend
	HR	95% CI		

Ratio of staff to beneficiaries 0.5-1.0

Initial use or dosage increase of cognitive enhancers

Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	0.999	0.374	-	2.671	0.0003
10-20 times/month	1.608	0.663	-	3.899	
More than 20 times/month	1.767	1.285	-	2.429	

Initial use or dosage increase of memantine

Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	0.908	0.226	-	3.642	0.0052
10-20 times/month	1.786	0.571	-	5.582	
More than 20 times/month	1.723	1.161	-	2.559	

Maximum dosage administration of cognitive enhancers

Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	0.807	0.201	-	3.235	0.0169
10-20 times/month	1.494	0.478	-	4.670	
More than 20 times/month	1.570	1.080	-	2.282	

Maximum dosage administration of memantine

Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	1.077	0.268	-	4.324	<.0001
10-20 times/month	2.140	0.684	-	6.694	
More than 20 times/month	2.276	1.568	-	3.305	

Delirium diagnosis

Cumulative amount of LTC service		
No LTC service	n.a	
Less than 10 times/month	n.a	
10-20 times/month	n.a	n.a
More than 20 times/month	n.a	

Emergency room visit due to dementia

Cumulative amount of LTC service		
No LTC service	n.a	n.a

	HR	95% CI			p-for-trend
Less than 10 times/month	n.a				
10-20 times/month	n.a				
More than 20 times/month	n.a				
Physical/mental dependency (Grade 1 or 2)					
Cumulative amount of LTC service					
No LTC service	n.a				
Less than 10 times/month	n.a				
10-20 times/month	n.a				n.a
More than 20 times/month	n.a				
Depression diagnosis					
Cumulative amount of LTC service					
No LTC service	n.a				
Less than 10 times/month	n.a				
10-20 times/month	n.a				n.a
More than 20 times/month	n.a				
All-cause mortality					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	2.282	1.083	-	4.809	
10-20 times/month	1.669	0.622	-	4.482	0.6759
More than 20 times/month	0.809	0.506	-	1.293	
Cardiovascular or cerebrovascular disease					
Cumulative amount of LTC service					
No LTC service	n.a				
Less than 10 times/month	n.a				
10-20 times/month	n.a				n.a
More than 20 times/month	n.a				
Femur fracture					
Cumulative amount of LTC service					
No LTC service	n.a				
Less than 10 times/month	n.a				
10-20 times/month	n.a				n.a
More than 20 times/month	n.a				

Variables	Hazard ratio			p-for-trend
	HR	95% CI		
Ratio of staff to beneficiaries more than 1.0				
Initial use or dosage increase of cognitive enhancers				
Cumulative amount of LTC service				
No LTC service	1.000			
Less than 10 times/month	0.726	0.301 -	1.751	
10-20 times/month	1.502	0.713 -	3.163	0.0718
More than 20 times/month	1.235	0.972 -	1.568	
Initial use or dosage increase of memantine				
Cumulative amount of LTC service				
No LTC service	1.000			
Less than 10 times/month	0.962	0.359 -	2.576	
10-20 times/month	2.086	0.932 -	4.667	0.0248
More than 20 times/month	1.229	0.910 -	1.661	
Maximum dosage administration of cognitive enhancers				
Cumulative amount of LTC service				
No LTC service	1.000			
Less than 10 times/month	2.079	1.111 -	3.891	0.0341
10-20 times/month	2.788	1.451 -	5.357	

	HR	95% CI			p-for-trend
More than 20 times/month	1.226	0.928	-	1.621	
Maximum dosage administration of memantine					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	1.945	0.920	-	4.111	0.0005
10-20 times/month	2.015	0.839	-	4.837	
More than 20 times/month	1.597	1.195	-	2.134	
Delirium diagnosis					
Cumulative amount of LTC service					
No LTC service	n.a				
Less than 10 times/month	n.a				
10-20 times/month	n.a				n.a
More than 20 times/month	n.a				
Emergency room visit due to dementia					
Cumulative amount of LTC service					
No LTC service	n.a				
Less than 10 times/month	n.a				
10-20 times/month	n.a				n.a
More than 20 times/month	n.a				
Physical/mental dependency (Grade 1 or 2)					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	1.573	0.503	-	4.920	0.0473
10-20 times/month	1.497	0.371	-	6.036	
More than 20 times/month	0.485	0.249	-	0.945	
Depression diagnosis					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	2.494	0.614	-	10.133	0.8975
10-20 times/month	3.619	0.891	-	14.698	
More than 20 times/month	0.890	0.413	-	1.917	
All-cause mortality					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	1.052	0.470	-	2.352	0.0727
10-20 times/month	0.763	0.245	-	2.374	
More than 20 times/month	0.756	0.553	-	1.032	
Cardiovascular or cerebrovascular disease					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	2.858	0.907	-	9.000	0.6453
10-20 times/month	1.358	0.190	-	9.722	
More than 20 times/month	1.084	0.584	-	2.014	
Femur fracture					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	1.274	0.177	-	9.153	0.1882
10-20 times/month	1.883	0.262	-	13.534	
More than 20 times/month	1.479	0.790	-	2.772	

Variables	Hazard ratio		p-for-trend
	HR	95% CI	
LTC facility capacity less than 30			

Initial use or dosage increase of cognitive enhancers

Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	1.535	1.047	-	2.252	0.027
10-20 times/month	1.584	1.067	-	2.353	
More than 20 times/month	1.161	0.980	-	1.376	
Initial use or dosage increase of memantine					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	1.068	0.587	-	1.942	0.0021
10-20 times/month	1.647	0.998	-	2.719	
More than 20 times/month	1.339	1.093	-	1.639	
Maximum dosage administration of cognitive enhancers					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	1.658	1.060	-	2.593	0.037
10-20 times/month	1.737	1.109	-	2.718	
More than 20 times/month	1.172	0.964	-	1.426	
Maximum dosage administration of memantine					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	2.051	1.278	-	3.293	<0.0001
10-20 times/month	2.414	1.537	-	3.790	
More than 20 times/month	1.525	1.238	-	1.877	
Delirium diagnosis					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	1.139	0.156	-	8.300	0.0137
10-20 times/month	1.190	0.163	-	8.671	
More than 20 times/month	2.081	1.175	-	3.686	
Emergency room visit due to dementia					
Cumulative amount of LTC service					
No LTC service	n.a				
Less than 10 times/month	n.a				n.a
10-20 times/month	n.a				
More than 20 times/month	n.a				
Physical/mental dependency (Grade 1 or 2)					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	1.685	0.831	-	3.419	0.0004
10-20 times/month	1.313	0.582	-	2.962	
More than 20 times/month	0.402	0.248	-	0.650	
Depression diagnosis					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	1.520	0.480	-	4.810	0.4417
10-20 times/month	2.683	1.090	-	6.605	
More than 20 times/month	1.094	0.672	-	1.780	
All-cause mortality					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	1.232	0.760	-	1.998	0.0025
10-20 times/month	0.834	0.458	-	1.517	
More than 20 times/month	0.714	0.574	-	0.887	

Cardiovascular or cerebrovascular disease					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	0.376	0.052	-	2.692	0.3258
10-20 times/month	1.549	0.571	-	4.203	
More than 20 times/month	0.760	0.467	-	1.235	
Femur fracture					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	0.488	0.068	-	3.505	0.5382
10-20 times/month	2.046	0.750	-	5.580	
More than 20 times/month	1.109	0.689	-	1.785	

Variables	Hazard ratio			p-for-trend
	HR	95% CI		
LTC facility capacity 30-60				
Initial use or dosage increase of cognitive enhancers				
Cumulative amount of LTC service				
No LTC service	1.000			
Less than 10 times/month	1.336	0.882 -	2.025	0.0191
10-20 times/month	1.193	0.735 -	1.937	
More than 20 times/month	1.205	1.021 -	1.421	
Initial use or dosage increase of memantine				
Cumulative amount of LTC service				
No LTC service	1.000			
Less than 10 times/month	1.796	1.120 -	2.881	0.0009
10-20 times/month	1.685	1.007 -	2.818	
More than 20 times/month	1.352	1.106 -	1.652	
Maximum dosage administration of cognitive enhancers				
Cumulative amount of LTC service				
No LTC service	1.000			
Less than 10 times/month	2.021	1.340 -	3.048	0.0012
10-20 times/month	2.253	1.495 -	3.395	
More than 20 times/month	1.267	1.051 -	1.527	
Maximum dosage administration of memantine				
Cumulative amount of LTC service				
No LTC service	1.000			
Less than 10 times/month	1.895	1.149 -	3.126	<.0001
10-20 times/month	2.372	1.481 -	3.801	
More than 20 times/month	1.609	1.314 -	1.972	
Delirium diagnosis				
Cumulative amount of LTC service				
No LTC service	n.a			
Less than 10 times/month	n.a			n.a
10-20 times/month	n.a			
More than 20 times/month	n.a			
Emergency room visit due to dementia				
Cumulative amount of LTC service				
No LTC service	1.000			
Less than 10 times/month	5.256	0.657 -	42.048	0.5863
10-20 times/month	5.657	0.707 -	45.273	
More than 20 times/month	1.117	0.237 -	5.260	
Physical/mental dependency (Grade 1 or 2)				
Cumulative amount of LTC service				

Variables	HR	95% CI			p-for-trend
No LTC service	1.000				
Less than 10 times/month	2.490	1.390	-	4.458	0.0001
10-20 times/month	0.883	0.328	-	2.377	
More than 20 times/month	0.389	0.240	-	0.630	
Depression diagnosis					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	0.520	0.072	-	3.738	0.2766
10-20 times/month	2.257	0.828	-	6.155	
More than 20 times/month	1.236	0.771	-	1.982	
All-cause mortality					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	1.678	1.107	-	2.545	0.0002
10-20 times/month	1.173	0.704	-	1.955	
More than 20 times/month	0.630	0.501	-	0.792	
Cardiovascular or cerebrovascular disease					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	2.189	0.963	-	4.976	0.8878
10-20 times/month	3.171	1.547	-	6.503	
More than 20 times/month	0.886	0.566	-	1.386	
Femur fracture					
Cumulative amount of LTC service					
No LTC service	n.a				
Less than 10 times/month	n.a				n.a
10-20 times/month	n.a				
More than 20 times/month	n.a				

Variables	Hazard ratio				p-for-trend
	HR	95% CI			
LTC facility capacity more than 60					
Initial use or dosage increase of cognitive enhancers					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	2.319	1.455	-	3.697	0.2236
10-20 times/month	1.069	0.504	-	2.271	
More than 20 times/month	1.115	0.885	-	1.405	
Initial use or dosage increase of memantine					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	2.405	1.320	-	4.382	0.1983
10-20 times/month	1.433	0.637	-	3.223	
More than 20 times/month	1.144	0.862	-	1.519	
Maximum dosage administration of cognitive enhancers					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	2.959	1.794	-	4.879	0.0785
10-20 times/month	1.681	0.831	-	3.399	
More than 20 times/month	1.170	0.905	-	1.513	
Maximum dosage administration of memantine					
Cumulative amount of LTC service					
No LTC service	1.000				0.0209
Less than 10 times/month	2.851	1.563	-	5.202	

	HR	95% CI			p-for-trend
10-20 times/month	1.158	0.430	-	3.114	
More than 20 times/month	1.346	1.012	-	1.791	
Delirium diagnosis					
Cumulative amount of LTC service					
No LTC service	n.a				
Less than 10 times/month	n.a				n.a
10-20 times/month	n.a				
More than 20 times/month	n.a				
Emergency room visit due to dementia					
Cumulative amount of LTC service					
No LTC service	n.a				
Less than 10 times/month	n.a				n.a
10-20 times/month	n.a				
More than 20 times/month	n.a				
Physical/mental dependency (Grade 1 or 2)					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	1.817	0.675	-	4.893	0.0072
10-20 times/month	1.017	0.252	-	4.105	
More than 20 times/month	0.411	0.218	-	0.776	
Depression diagnosis					
Cumulative amount of LTC service					
No LTC service	n.a				
Less than 10 times/month	n.a				n.a
10-20 times/month	n.a				
More than 20 times/month	n.a				
All-cause mortality					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	1.275	0.635	-	2.558	0.0159
10-20 times/month	1.626	0.837	-	3.157	
More than 20 times/month	0.654	0.483	-	0.887	
Cardiovascular or cerebrovascular disease					
Cumulative amount of LTC service					
No LTC service	n.a				
Less than 10 times/month	n.a				n.a
10-20 times/month	n.a				
More than 20 times/month	n.a				
Femur fracture					
Cumulative amount of LTC service					
No LTC service	n.a				
Less than 10 times/month	n.a				n.a
10-20 times/month	n.a				
More than 20 times/month	n.a				

Variables	Hazard ratio				p-for-trend
	HR	95% CI			
LTC facilities with fewer than 10 staff members					
Initial use or dosage increase of cognitive enhancers					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	1.478	1.065	-	2.051	0.02
10-20 times/month	1.406	0.998	-	1.983	
More than 20 times/month	1.161	1.001	-	1.346	

Initial use or dosage increase of memantine					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	1.401	0.903	-	2.175	0.0014
10-20 times/month	1.397	0.900	-	2.171	
More than 20 times/month	1.320	1.102	-	1.582	
Maximum dosage administration of cognitive enhancers					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	1.867	1.310	-	2.660	0.0238
10-20 times/month	1.890	1.332	-	2.682	
More than 20 times/month	1.151	0.968	-	1.369	
Maximum dosage administration of memantine					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	1.967	1.310	-	2.952	<.0001
10-20 times/month	2.495	1.736	-	3.587	
More than 20 times/month	1.432	1.185	-	1.731	
Delirium diagnosis					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	0.808	0.111	-	5.904	0.0074
10-20 times/month	2.362	0.725	-	7.696	
More than 20 times/month	2.015	1.179	-	3.445	
Emergency room visit due to dementia					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	3.044	0.386	-	24.035	0.168
10-20 times/month	5.939	1.282	-	27.506	
More than 20 times/month	1.731	0.580	-	5.167	
Physical/mental dependency (Grade 1 or 2)					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	2.367	1.441	-	3.887	<.0001
10-20 times/month	0.944	0.444	-	2.009	
More than 20 times/month	0.421	0.282	-	0.629	
Depression diagnosis					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	1.339	0.490	-	3.656	0.2393
10-20 times/month	1.658	0.673	-	4.084	
More than 20 times/month	1.236	0.821	-	1.861	
All-cause mortality					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	1.681	1.189	-	2.378	<.0001
10-20 times/month	0.970	0.621	-	1.516	
More than 20 times/month	0.655	0.538	-	0.799	
Cardiovascular or cerebrovascular disease					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	1.232	0.503	-	3.022	0.4678
10-20 times/month	2.164	1.096	-	4.273	

Variables	Hazard ratio					p-for-trend
	HR		95% CI			
More than 20 times/month	0.783	0.517	-	1.186		
Femur fracture						
Cumulative amount of LTC service						
No LTC service	n.a					
Less than 10 times/month	n.a					
10-20 times/month	n.a					n.a
More than 20 times/month	n.a					

Variables	Hazard ratio				p-for-trend
	HR		95% CI		
LTC facilities with 10 to 30 staff members					
Initial use or dosage increase of cognitive enhancers					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	1.678	1.040	-	2.707	
10-20 times/month	1.025	0.529	-	1.987	0.1725
More than 20 times/month	1.132	0.930	-	1.378	
Initial use or dosage increase of memantine					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	1.689	0.903	-	3.159	
10-20 times/month	1.718	0.890	-	3.317	0.0366
More than 20 times/month	1.240	0.977	-	1.573	
Maximum dosage administration of cognitive enhancers					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	1.967	1.157	-	3.343	
10-20 times/month	1.814	1.000	-	3.290	0.0135
More than 20 times/month	1.256	1.011	-	1.561	
Maximum dosage administration of memantine					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	2.201	1.209	-	4.004	
10-20 times/month	1.359	0.611	-	3.023	<.0001
More than 20 times/month	1.571	1.243	-	1.985	
Delirium diagnosis					
Cumulative amount of LTC service					
No LTC service	n.a				
Less than 10 times/month	n.a				
10-20 times/month	n.a				n.a
More than 20 times/month	n.a				
Emergency room visit due to dementia					
Cumulative amount of LTC service					
No LTC service	n.a				
Less than 10 times/month	n.a				
10-20 times/month	n.a				n.a
More than 20 times/month	n.a				
Physical/mental dependency (Grade 1 or 2)					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	1.464	0.544	-	3.941	
10-20 times/month	1.623	0.602	-	4.378	0.0006
More than 20 times/month	0.335	0.183	-	0.616	
Depression diagnosis					

Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	0.912	0.127	-	6.555	0.274
10-20 times/month	3.071	0.968	-	9.745	
More than 20 times/month	1.249	0.729	-	2.140	

All-cause mortality

Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	1.161	0.603	-	2.237	0.0047
10-20 times/month	1.272	0.656	-	2.467	
More than 20 times/month	0.671	0.517	-	0.870	

Cardiovascular or cerebrovascular disease

Cumulative amount of LTC service					
No LTC service	n.a				
Less than 10 times/month	n.a				n.a
10-20 times/month	n.a				
More than 20 times/month	n.a				

Femur fracture

Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	0.839	0.117	-	6.025	0.8387
10-20 times/month	0.948	0.132	-	6.813	
More than 20 times/month	1.065	0.616	-	1.842	

Variables	Hazard ratio				p-for-trend
	HR	95% CI			

LTC facilities with more than 30 staff members

Initial use or dosage increase of cognitive enhancers

Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	2.100	1.218	-	3.622	0.0427
10-20 times/month	1.729	0.775	-	3.861	
More than 20 times/month	1.226	0.957	-	1.571	

Initial use or dosage increase of memantine

Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	2.470	1.276	-	4.783	0.03
10-20 times/month	2.074	0.860	-	5.005	
More than 20 times/month	1.297	0.962	-	1.748	

Maximum dosage administration of cognitive enhancers

Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	3.106	1.789	-	5.393	0.0127
10-20 times/month	1.789	0.742	-	4.312	
More than 20 times/month	1.314	1.000	-	1.726	

Maximum dosage administration of memantine

Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	2.869	1.480	-	5.560	0.0001
10-20 times/month	0.979	0.244	-	3.926	
More than 20 times/month	1.711	1.284	-	2.279	

Delirium diagnosis

Cumulative amount of LTC service					
No LTC service	n.a				n.a

	HR	95% CI			p-value
Less than 10 times/month	n.a				
10-20 times/month	n.a				
More than 20 times/month	n.a				
Emergency room visit due to dementia					
Cumulative amount of LTC service					
No LTC service	n.a				
Less than 10 times/month	n.a				n.a
10-20 times/month	n.a				
More than 20 times/month	n.a				
Physical/mental dependency (Grade 1 or 2)					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	1.675	0.536	-	5.236	0.025
10-20 times/month	0.836	0.117	-	5.964	
More than 20 times/month	0.441	0.218	-	0.893	
Depression diagnosis					
Cumulative amount of LTC service					
No LTC service	n.a				
Less than 10 times/month	n.a				n.a
10-20 times/month	n.a				
More than 20 times/month	n.a				
All-cause mortality					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	0.960	0.398	-	2.316	0.1252
10-20 times/month	2.359	1.174	-	4.740	
More than 20 times/month	0.725	0.523	-	1.005	
Cardiovascular or cerebrovascular disease					
Cumulative amount of LTC service					
No LTC service	1.000				
Less than 10 times/month	1.985	0.491	-	8.027	0.9141
10-20 times/month	4.541	1.444	-	14.276	
More than 20 times/month	0.791	0.387	-	1.616	
Femur fracture					
Cumulative amount of LTC service					
No LTC service	n.a				
Less than 10 times/month	n.a				n.a
10-20 times/month	n.a				
More than 20 times/month	n.a				

Abbreviation: LTC; long-term care, HR; hazard ratio, CI; confidence interval, n.a; not applicable

Abstract in Korean

보편적 노인장기요양보험의 재가 급여 서비스 이용과 치매 환자의 치매 진행 위험 및 건강 상태

배경: 2008년 8월 도입된 대한한국의 노인장기요양보험(Long-term care insurance)은 치매 환자에 대한 보다 광범위한 보장을 포함하도록 확장되었다. 2018년 1월 인지지원등급(Cognitive Assistance Grade) 도입으로 모든 치매 환자에게도 서비스가 확대되어 주야간 보호 서비스를 포함한 재가급여를 제공하게 되었다. 많은 연구에서 노인장기요양보험의 확장이 비공식적 돌봄 및 의료비 감소와 관련되어 있다는 것이 확인되었으나, 노인장기요양보험의 확장과 건강 변화, 특히 치매 진행과 관련된 연구는 여전히 부족하다. 노인장기요양보험법에 명시된 보험의 목적에 맞춰, 이 연구는 인지지원등급 수급자와 비수급자 간의 치매 진행 및 기타 건강 상태의 차이를 분석하고자 한다, 또한, 인지지원등급 수급자의 치매 진행에 대한 노인장기요양 서비스 이용의 영향을 평가하고자 한다. 또한,

방법: 이 연구는 대한한국 전체 치매 환자의 절반의 데이터를 포함하는 국민건강보험공단-맞춤형연구자료를 사용하여 수행된 후향적 관찰 연구이다. 치매 중증도를 포함한 환자 특성을 반영한 경향 점수(propensity score)에서 파생된 1:1 매칭을 사용하여, 인지지원등급 수혜자와 해당 시점에 치매 진단을 받은 노인장기요양보험 비수혜자를 선정하였다. 1차 결과(primary outcome)는 노인장기요양보험 내 인지기능 영역 점수를 사용하여 평가된 인지 저하(cognitive decline)이다. 2차 결과(secondary outcome)에는 치매 약물의 용량 증가, 섬망 진단, 치매로 인한 응급실 방문과 같은 치매 진행의 대리 지표를 사용하였다. 또한 우울증 진단, 정신적 및 신체적 의존성, 모든 원인 사망률과 같은 변수를 분석했으며, 대퇴골 골절 진단과 같은 결과 변수에 대한 대조 변수도 포함되었다. 노인장기요양 서비스 이용 빈도에 따른 용량 의존적 연관성(dose-dependent trend)을 분석하였으며, 초기 치매 특성, 노인장기요양 시설 특성, 노인장기요양 서비스 유형에 따라 하위 분석을 수행하였다.

결과: 총 8,511명의 CAG 수급자와 8,511명의 비수급자가 연구에 포함되었다. 인지지원등급 수급자는 비수급자에 비해 치매 진행 위험(HR: 3.329, 95% CI: 3.000-3.695)과 다른 건강 상태가 더 악화되는 위험을 보였다. 그러나 노인장기요양

서비스를 월 20회 이상 이용한 경우, 한 번도 이용하지 않은 경우에 비해 인지 저하 위험이 유의하게 감소했으며, 이용 빈도에 따른 용량−의존적 감소 추세가 관찰되었다(hazard ratio [HR]: 0.696, 95% confidence interval [CI]: 0.598−0.809, p−for−trend: <0.0001). 경증 인지저하 증상을 가진 환자, 행동 증상이 없는 환자, 85세 미만의 환자에서 이와 비슷한 유의성과 경향이 관찰되었다. 재가 방문 요양서비스에서도 이와 유사한 유의성과 경향이 나타났으며, 모든 이용 빈도에서 인지 저하 위험이 유의미하게 감소했다(HR: 0.500, 95% CI: 0.295−0.847, 월 10회 미만 이용; HR: 0.564, 95% CI: 0.332−0.958, 월 10−20회 이용; HR: 0.501, 95% CI: 0.386−0.651, 월 20회 이상 이용; p−for−trend: <0.0001). 그러나 주야간 보호 서비스에서는 유의미한 효과가 발견되지 않았다. 다만, 직원 대 수급자 비율이 1.0을 초과하는 주야간 보호 시설에서는, 월 20회 이상 이용 시 인지 저하 위험이 유의하게 감소하는 것으로 나타났다(HR: 0.655, 95% CI: 0.456−0.940, 추세에 대한 p값: 0.0311).

결론: 노인장기요양보험을 비수혜자 및 치매 외에 다른 노인성 질환까지 확대하는 것이 필요할 수 있으며, 특히 조기 개입을 통해 인지 저하를 늦추는 데 도움이 될 수 있다. 젊은 치매 환자와 경미한 증상의 환자들이 더 낮은 인지기능 저하 경향을 보였으며, 반면 중증도가 상대적으로 높은 5등급 수급자는 개선이 제한적이어서, 조기에 LTCI에 참여하는 것이 중요함을 시사한다. 또한, 효과적인 돌봄을 위해서는 높은 직원 대 수급자 비율 개선과 수급자 맞춤형 중재가 필요하다. 다만, 치매 유병률 증가와 노인장기요양보험 비용이 늘어나고 있어, 이에 대한 비용 효과성도 고려되어야 한다. 2018년 노인장기요양보험이 모든 치매 환자를 대상으로 보편적 보장을 제공함에도 불구하고 여전히 많은 사람들이 가입하지 않았다. 따라서, 인지지원등급 수급자와 비수급자 간 치매 상태의 임상적 차이와 노인장기요양보험을 신청하지 않은 이유를 확인하기 위한 추가 연구가 필요하다.

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