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Factors Influencing the Problem
of Cognitive Function in Older
Adults at the End of Life

A Dissertation
Submitted to the
Graduate School of Sungshin University

in partial fulfillment of the requirements
for the degree of
Doctor of Nursing Science

WANG MENGYU

June, 2024

Factors Influencing the Problem
of Cognitive Function in Older
Adults at the End of Life

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2024


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ABSTRACT

Factors Influencing the Problem of Cognitive Function in Older Adults at the End of Life

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Objectives: This study investigated factors influencing the problem of cognitive function in older adults in the last month before death.

Methods: This cross-sectional and correlational study analyzed secondary data from 2008–2018 Korean older adults population survey data (Korean Longitudinal Study of Aging). The study included older adults aged 65 and older who died of disease, and excluded those with dementia or memory impairment as a chronic disease. Complex-sample logistic regression was conducted using 999 older adults. Statistical analyses were performed using IBM SPSS 26.0 statistical software package. Statistical significance was set at $p < 0.05$.

Results: Age at the time of death was $79.45 \pm .27$ years old, and 24.5% of older adults have the problem of cognitive function in the last month before death in this study. In the multivariate logistic regression

analysis, age at the time of death, stroke, fall experienced before death, dependence on activities of daily living (ADL) during 3 months before death, main bearer of medical expenses, and type of insurance were significant factors influencing the problem of cognitive function. The model explained 13.7% (Cox and Snell R^2) and 20.5% (Nagelkerke R^2) of the problem of cognitive function in older adults at the end of life. The fitting results of the model were satisfactory and significant ($F=4.096$, $p<.001$).

Conclusions: The study findings indicate that age at death, stroke, falls experienced before death, dependence on ADL during the last three months before death, main bearer of medical expenses, and type of insurance significantly influence the problem of cognitive function in older adults at the end of life. Based on the results of this study, future research could focus on developing more targeted intervention plans to alleviate the problem of cognitive function in older adults at the end of life and improve their quality of life before death.

Key words: Older adults, Cognitive function, Terminal Care

Acknowledgments

During my Ph.D. studies in South Korea, I received support and encouragement from many people to whom I owe my deepest gratitude. Their care and assistance enabled me to successfully complete my doctoral dissertation.

First and foremost, I would like to express my special thanks to my advisor, Professor Cheon Jooyoung. Her meticulous guidance and patient help during my time in South Korea were invaluable. Her expertise, rigorous academic attitude, and unwavering care for her students provided me with the motivation and confidence to pursue my research in a foreign land. Her invaluable suggestions and feedback were instrumental in the smooth progress and successful completion of my study. Her patience and continuous encouragement were crucial. Without her guidance, support, and trust in me, I would not have been able to complete this dissertation.

Secondly, I am grateful to my dissertation committee members, Professor Cho Chung-Min, Professor Yang Seung-Ae, Professor Kim Young-Joo, and Professor Choi Eun-Young,. I appreciate their support, valuable suggestions, and rigorous review during the writing and defense of my dissertation.

I would also like to thank the friends I made in South Korea. Thanks to Na Yoon-Hoi, Choi Mi-Kyung, Park Bok-Hee, Kim Hyun-Sook, Park Yoon-Joo, Kim Eun-Hee, Koo Hyo-Hoon, Nam Sun-Hee, Kim In-Soo, Jung So-Hyung and Kim Mi-Kyung for their guidance, care, and

support in both my studies and daily life, making me feel less alone in a foreign country. The time spent with you all will be among my most cherished memories.

Finally, I am immensely grateful to my family. Despite the great distance between us, their unwavering support and encouragement provided me with endless motivation. Without their love, support, and encouragement, this dissertation would not have been possible. I am thankful to my parents, whose love and care have always been a source of strength no matter where I am. I am also grateful to my husband for his understanding and support, which allowed me to persevere in the face of challenges and pursue my academic dreams. Having you all in my life is my greatest blessing.

Contents

Abstract (English)

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I. Introduction

1. Background

The latest statistical data reveal that the global population aged 60 years and above has already constitutes a significant proportion of the total population (World Population Ageing 2019), and is projected to increase further in the coming decades. This indicates that regions worldwide face the ongoing challenge of a continuously growing aging population. South Korea, in particular, is experiencing rapid aging and is transitioning from an "aging society" to a "super-aged society." The number of individuals over 65 years of age in South Korea has been steadily increasing, reaching approximately 9.046 million as of November 2022, accounting for 17.5% of the total population. By 2025, this proportion is expected to surpass 20%, officially marking South Korea's entry into a "super-aged society" (Statistics Korean, 2022).

With the rapidly aging global population, an increasing number of individuals with the problem of cognitive function will face the end-of-life stage, imposing significant psychological burdens on both the affected older adults and their families, and economic burdens on healthcare systems due to the placing of higher demands (Lu et al., 2022; Deardorff et al., 2019). In particular, the end-of-life stage represents a unique phase in the human lifespan, during which older adults often experience a sharp or complete decline in cognitive function and daily activities (Alber et al., 2019). In most cases, when they reach

this stage, older adults require care provided by family members (Clare & Wu, 2019). Therefore, a deeper understanding of the characteristics, predictive factors, and corresponding coping strategies for the problem of cognitive function is needed in older adults by the end of their lives.

Cognitive function refers to the ability of the brain to execute advanced neural activities, including perception, learning, memory, thinking, and problem solving. This involves the coordinated functioning of neural networks to respond to external stimuli and appropriately process internal information (Berry et al., 2016). Cognitive function is not only a crucial aspect of individual adaptation to the environment and coping with challenges but is also one of the distinctive intellectual features of humanity (Jordan et al., 2023). Throughout the lifespan, the significance of cognition is primarily evident in the process of successful aging, and the extension of life expectancy and disability-free life expectancy, all of which concurrently exert significant impacts on successful longevity and well-being (Sánchez-Izquierdo & Fernández-Ballesteros, 2021).

At the end of life, older adults perceive a good quality of life as encompassing pain and symptom control, maintaining a certain level of cognitive function, preparing for death, feeling satisfied with their life trajectory, and being able to make treatment decisions according to their wishes (Krikorian, Maldonado, & Pastrana, 2020). Additionally, they desire to be seen as "whole individuals" by others (Park, Lim, & Yoon, 2019). Cognitive function plays a crucial role in these processes and influences the quality of life and end-of-life experiences of older adults.

Preserving cognitive function helps older adults accurately express pain and discomfort, facilitating timely medical intervention and pain management (Samper-Ternent et al., 2021). Moreover, maintaining cognitive function enables them to sustain their independence, reduce emotional problems such as depression and anxiety, and enhance their overall quality of life (Robinson, Connelly, & Georges, 2022). Older adults with good cognitive function are better able to comprehend and accept the end-of-life stage, engage in life reviews, find meaning and fulfillment in life, and prepare psychologically for death (Meier et al., 2016; Takahashi et al., 2021).

Furthermore, cognitive functioning enables older adults to be more satisfied with their life trajectory, engage in positive emotional regulation, and enhance feelings of happiness and satisfaction (Davis et al., 2015). They can also comprehend complex medical information, evaluate treatment options, align treatment decisions with their preferences, and reduce decision errors and uncertainties resulting from the problem of cognitive function (Ho et al., 2021). Preserving their cognitive function also allows them to continue participating in social activities and interpersonal interactions, maintain social roles and identity, and experience respect and care (Lee, Small, & Haley, 2020; Wehrmann et al., 2021). Therefore, in-depth research into the problem of cognitive function in older adults at the end of life is of paramount significance for enhancing their quality of life experience.

During the end-of-life stage, older adults face various complex and intertwined challenges, including significant declines in quality of life,

increased healthcare needs, diminished decision-making capacity, and family caregiving pressures (Hill et al., 2017; Keramat et al., 2023; Alfeo et al., 2024; Amaral et al., 2022; Lin et al., 2017). At the core of all these problems often lies the problem of cognitive function in older adults. Therefore, in-depth research into cognitive function problems in older adults at the end of life is crucial.

The problem of cognitive function directly affects the quality of life in older adults. During the end of life, a sharp or complete decline of cognitive function is common (Alber et al., 2019), affecting not only their daily functioning but also leading to severe emotional problems such as depression and anxiety (Robinson, Connelly, & Georges, 2022). Older adults with the problem of cognitive function may forget basic daily activities, lose effective communication with others, and fail to meet their basic needs (Alber et al., 2019; Clare & Wu, 2019). These problems significantly diminish their quality of life, subjecting them to greater suffering and distress in the final stages of their life (O'Connor, 2021). Therefore, understanding and addressing the problem of cognitive function can help improve older adults' quality of life, allowing them to live with dignity and comfort until the end of their lives.

Additionally, the problem of cognitive function significantly increase healthcare needs. Older adults with the problem of cognitive function typically require more frequent medical monitoring, medication management, and nursing services (Alfeo et al., 2024), thus necessitating the use of additional resources and services from the healthcare system. As health deteriorates, healthcare needs for older adults at the end of life

significantly increases, adding burden not only to the healthcare system but also imposing significant economic pressure on families (Lu et al., 2022; Deardorff et al., 2019). By studying the problem of cognitive function, more effective medical interventions can be developed to alleviate the burden on older adults and their families, enhancing the efficiency of healthcare resource utilization.

Furthermore, the problem of cognitive function presents significant challenges for older adults while making medical decisions. At the end of their life, older adults face many important medical decisions (Perrels et al., 2014), such as choosing treatment plans, making prognosis plans, and signing medical proxies. However, the problem of cognitive function make it difficult for older adults to fully understand complex medical information and articulate their wishes clearly (Amaral et al., 2022; Alfeo et al., 2024). This not only increases difficulties for healthcare teams in the decision-making process but also adds uncertainty and pressure for family members to act as decision-makers (Scheltens et al., 2021). In-depth research on the problem of cognitive function and its impact on decision-making capacity can help improve medical decision support systems, ensuring that older adults receive medical services that align with their wishes and interests at the end of their lives.

Additionally, family caregiving pressures is closely linked to the cognitive function status of older adults. Older adults with the problem of cognitive function often require more daily care and supervision, which pose a significant burden on their family members (Kim et al., 2018). Prolonged caregiving tasks can lead to emotional exhaustion,

depression, and anxiety among family members, and may also trigger conflicts and tensions within the family (Lin et al., 2017). Family caregiving often comes with high economic costs, further exacerbating family pressures.

Therefore, researching the problem of cognitive function in end-of-life older adults is crucial. This not only concerns the quality of life and well-being of older adults in their final stages, but also has profound implications for healthcare systems and family caregiving. By gaining a deeper understanding of these problems, we can develop more effective interventions and policies to enhance the quality of life of older adults at the end of their life, optimize the medical decision-making process, and alleviate the burden of caregiving on families. This has practical significance and societal value in addressing the increasingly prominent problem of cognitive function in the context of the population.

2. Study purpose

This study investigated the factors influencing the problem of cognitive function in South Korean older adults in the last month before their death. The findings of this study provide a basis for developing intervention programs to improve the quality of end-of-life care and reduce the burden on older adults, their families, and society at large.

3. Research gap

Previous studies have focuses on the problem of cognitive function decline in patients with dementia and the general elderly population within communities (Amaral et al., 2022; Clare et al., 2019; Ho et al., 2021; Livingston et al., 2017; Mitchell et al., 2018). There is relatively little research on the factors influencing cognitive function in older adults at the end of their life. Additionally, existing research has often prioritized problems such as pain and symptom management, depression, and end-of-life decision-making (Samper-Ternent et al., 2021; Robinson, Connelly, & Georges, 2022; Ho et al., 2021), overlooking the problem of cognitive function at the end of life. However, considering the crucial role of cognitive function in the quality of life and end-of-life experiences of older adults, in-depth research on cognitive function problems at the end of life is particularly important. Therefore, it is necessary to examine the factors influencing the problem of cognitive function in older adults at the end of life to enhance their quality of life so they may have a dignified end-of-life experience.

4. Theoretical background

1) Basic concept

In 1977, the American psychologist Bronfenbrenner first proposed the ecological theory, suggesting that human health is influenced by various

environmental factors (Bronfenbrenner, 1977). He categorized the factors affecting individual health into four levels: the microsystem, representing the personal level; the mesosystem, representing the interpersonal level; the exosystem, representing the community level; and the macrosystem, representing the societal level. In 1988, McLeroy et al. expanded Bronfenbrenner's theory to the field of health promotion, leading to the development and refinement of the Health Ecological Model (HEM) (McLeroy et al., 1988). This model posits that individual health is influenced by multiple factors, including oneself, the environment, public policies, and societal culture, with these factors being interdependent, interactive, and mutually restrictive.

The HEM consists of five levels: the core at the individual level (intrapersonal level), which primarily encompasses factors such as age, gender, and susceptibility to diseases. Moving outward, the interpersonal level, involves aspects such as lifestyle and psychological state. Another layer is the organizational level, which includes factors such as family relationships, community involvement, and social networks. Subsequently, the community level comprises elements such as economic income, occupation, and living environment. The outermost layer is the public policy level, as shown in Figure 1. The factors within these five levels interact with each other, and play crucial roles in influencing individual health.



Fig 1. Health Ecological Model

Research on HEMs originated earlier and has been more widely applied abroad, mainly in areas such as factors influencing health-related behaviors, self-management of chronic diseases, and compliance with chronic disease screening. Scholars like Sallis et al. (2006) have explored the influence of different levels such as individual, social environment, physical environment, and policy environment on individual physical activity behavior from the perspective of health ecology, proposing comprehensive intervention measures at multiple levels. Richard et al. (2004) incorporated the ecological model into smoking control research, designing intervention measures from multiple levels upstream,

midstream, and downstream. Scholars such as Kulinna (2013) have explored the relationship between adolescent physical activity and health behaviors based on the health ecological model, and found that psychosocial factors play a crucial role in adolescent physical activity and health behaviors. Fisher et al. (2005) applied the health ecological model to research on approaches for the self-management of diabetes patients.

2) Application of the Health Ecological Model to cognitive function

HEMs consider individual health at various levels, such as individual level, interpersonal level, organizational level, community level, and public policy level. In the context of cognitive function in older adults at the end of their lives, a HEM could be applied across the following five aspects:

Individual level: This involves genetic characteristics, basic physiological status, and individual differences related to cognitive function in older adults. The study found significant correlations between individual factors such as occupation, ethnicity, age, education level, health status, level of emotional support, religious beliefs, and economic satisfaction and cognitive function (Hsu & Bai, 2022). This finding implies that understanding individual-level factors in older adults is crucial for maintaining cognitive function at the end of life.

Interpersonal level: This involves the lifestyle, cognitive activities, and other behaviors related to cognitive function in older adults.

Research indicates that positive lifestyle choices, such as engaging in social and physical activities, are associated with the maintenance of cognitive function (Livingston et al., 2020). Cognitive activities, such as reading and learning, are also linked to the protection of cognitive function.

Organizational level: This considers the relationships of older adults with family, friends, and the community. Social support and positive interpersonal relationships are believed to positively impact on the cognitive function in older adults (Kelly et al., 2017). Interacting with others and social engagement are considered protective factors for cognitive function in the later stages of life.

Community level: This involves the living environment, community setting, and healthcare services for older adults. A community environment friendly to older adults, with features such as accessibility, cultural adaptability, and safety, contributes to the provision of support for cognitive function (Wu, Prina, & Brayne, 2015). The accessibility of healthcare services is also crucial.

Public policy level: This level focuses on governmental and societal factors, such as policies related to healthcare for older adults and social welfare. Developing policies that support cognitive function in older adults, such as cognitive rehabilitation services and policies that promote social participation, plays a critical role in protecting cognitive function (Petersen et al., 2018).

3) Research model

Based on the finding of the literature review and the availability of data from a secondary retrospective longitudinal panel study, this study establishes a conceptual model to understand the factors that influence the problem of cognitive function in older adults at the end of life, using the HEM as the research framework. Figure 2 illustrates this research framework. The study focuses on individual level, interpersonal level, organizational and community level, and public policy level.

Specifically, the individual level encompasses demographics including age, gender, educational level, and health-related factors such as chronic disease, pain, falls, and activities of daily living. Interpersonal levels encompass family related factors, including marital status and the number of living children, and lifestyle factors, including alcohol consumption and smoking status. Organizational and community levels involve the main bearer of medical expenses, place of death, and residential area. Public policy level involves the type of insurance.

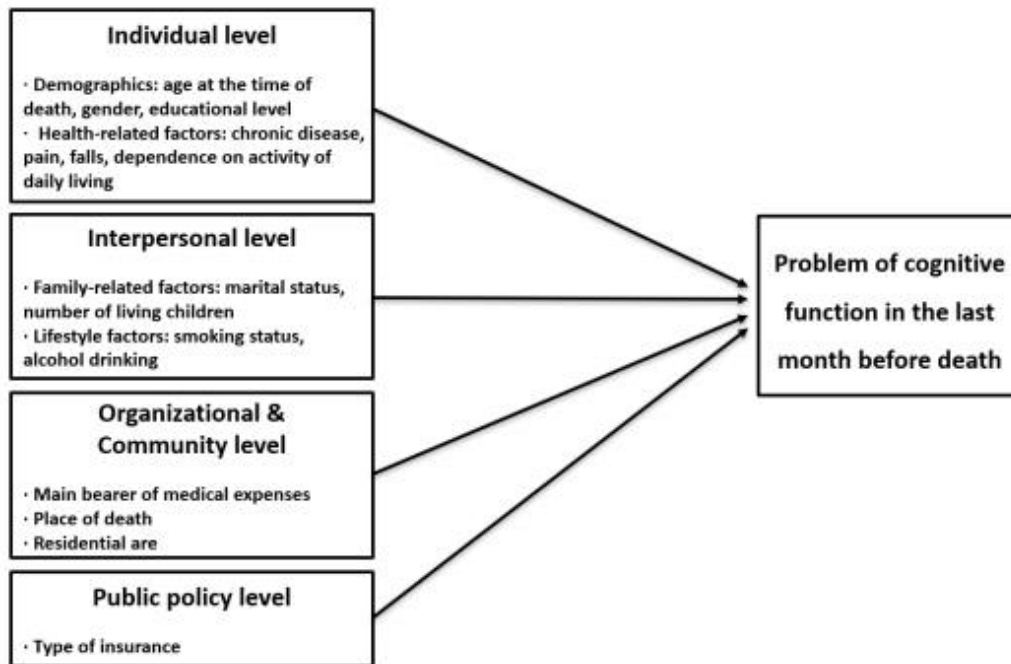


Fig 2. Conceptual framework of this study

II. Review of the literature

1. The problem of cognitive function in older adults at the end of life

The problem of cognitive function in older adults is a critical for the study of healthy aging. Numerous longitudinal studies have identified various factors and patterns influencing these changes. Longitudinal studies can identify different trajectories of change in the cognitive function of older adults. Based on a Korean Longitudinal Study on Aging (KLoSA), Park et al. (2023) identified two main trajectories: "high-level decline" and "low-level stable." In the "high-level decline" trajectory, older adults initially have normal cognitive function but gradually decline to mild cognitive impairment (MCI) levels over a period of 14 years. In contrast, those in the "low-level stable" trajectory have low cognitive function from the start and remain stable throughout the study period (Park, Jeong, & Lee, 2023; Park, Lee, & Jeong, 2023). Similar cognitive trajectories were identified in studies conducted in other countries. Tu et al. (2020) found that changes in cognitive function among older adults in China could be categorized into three trajectories: stable, slow decline, and rapid decline.

Various factors influence the problem of cognitive function in older adults, including socioeconomic status, educational level, psychological health, physical health, and lifestyle. Depression is a significant predictor

of cognitive decline. Park and colleagues (2023) found that higher initial levels of depression were associated with lower initial cognitive function, and that older adults with higher levels of depression experienced rapid cognitive decline. Similarly, depression has been found to be significantly related to cognitive decline in older adults with cardiovascular disease (Son et al., 2024). Educational level and social participation also significantly impacted cognitive trajectories. Older adults with higher educational levels, active social engagement, and regular exercise are more likely to maintain stable cognitive function (Min, 2018). Zaninotto et al. (2018) showed that higher education levels are associated with slower rates of decline in memory, executive function, and overall cognitive function. Zhang et al. (2019) studied the changes in cognitive function and risk factors for cognitive impairment in older adults in China, and found that age, lack of education, low frequency of leisure activities, and low baseline cognitive function were major factors in cognitive decline. Gender differences are also important factors affecting cognitive trajectories (Zhang et al., 2019). Lobo et al. (2023) found that women have lower average cognitive scores at all stages and experience more significant cognitive loss over time. Men's cognitive trajectories are influenced by alcohol consumption status and dependence on instrumental activities of daily living (IADL) dependence, whereas women are more affected by depression and diabetes (Lobo et al., 2023). Tu et al. (2024) found that women are more likely to experience slow and rapid cognitive decline than men.

Common cognitive impairments at the end of life in older adults

include hallucinations, delirium, and disorientation. In their systematic review Silva et al. (2024) found that these cognitive impairments have a high incidence during the end-of-life period, affecting the patients' consciousness and cognitive function. These impairments not only affect the cognitive experience of patients but also cause emotional and psychological burdens for their family and caregivers (Silva, Ribeiro, & Moreira-Almeida, 2024).

In terms of the problem of cognitive function in terminally ill older adults, the current research focused on cognitive decline, end-of-life planning, and quality of care. Older adults experience a significant decline in the last few months or weeks of life. Mitchell et al. (2018) found that cognitive function in older adults is commonly affected during the end-of-life period, possibly associated with physiological aging, the progression of chronic diseases, and the direct effects of end-of-life illnesses. Cognitive function decline may affect patients' understanding and participation in medical decision-making, emphasizing the need for special attention to patients' cognitive status end-of-life care (Ho et al., 2021).

The problem of cognitive function may impact older adults' participation in end-of-life planning. Research indicates that in cases of the problem of cognitive function, older adults may struggle to clearly express their personal wishes, making the process of end-of-life planning more complex (Nicholas et al., 2023). Regarding the quality of care, research suggests that providing appropriate care and support is crucial for older adults with cognitive function decline at the end of life.

Good-quality care is associated with the maintenance of cognitive function and the improvement of life quality in older adults (Verreault et al., 2018).

2. Factors influencing the problem of cognitive function in older adults

1) Individual level

Age is a crucial factor that influences the problem of cognitive function in older adults. Numerous studies have shown that advanced age is an independent risk factor for cognitive decline (Lehert et al., 2015). Jia et al.(2020) found that the overall prevalence of the problem of cognitive function among older adults in China increased with age, with rates of 11.9% in the 60-69 age group, 19.3% in the 70-79 age group, 24.4% in the 80-89 age group, and 33.1% in those aged 90 years and above. Results from the U.S. MCI Practice Guidelines indicate that the prevalence of the problem of cognitive function varies across age groups, with rates of 6.7% in the 60-64 age group, 8.4% in the 65-69 age group, 10.1% in the 70-74 age group, 14.8% in the 75-79 age group, 25.2% in the 80-84 age group, and 37.6% in those aged 85 and above (Petersen et al., 2018). A longitudinal study in the U.S. reported prevalence rates of 3.2%, 9.9%, and 29.3% in different age groups 65-74, 75-84, and 85 and above, respectively (Langa et al., 2017). Additionally, research indicates that cognitive function tends to decline with age, although these changes

are not universally inevitable and significant inter-individual differences exist (Park & Festin, 2017). Older adults, especially at the end of life, experience a combination of increased prevalence of chronic diseases, increased physical dependence, decreased psychological and social adaptability, and lack of family and social support which can accelerate the problem of cognitive function (Park & Festini, 2017; Petersen et al., 2018; Rook & Charles, 2017). It is evident that as age increases, the risk of the problem of cognitive function in older adults rises continuously, which is reflected in the significantly higher prevalence rates in the oldest age groups.

Research on the association between gender and the problem of cognitive function has yielded mixed results. In the older adult population, women are more likely than men to experience problems related to cognitive function (Zhang et al., 2019; Miyazaki & Liu, 2019; Petersen et al., 2010). This trend is often attributed to socio-economic factors. In economically disadvantaged regions, women have limited opportunities to participate in society and have less access to higher education (Miyazaki & Liu, 2019). In addition, some studies have shown that women experience more rapid the problem of cognitive function during aging despite having greater cognitive reserves, making them more vulnerable to facing problems with cognitive function (Levine et al., 2021). Conversely, other studies have observed a higher prevalence of mild the problem of cognitive function in men than in women (Terreni et al., 2003). Moreover, some studies indicated an absence of a significant correlation between gender and the prevalence of the problem

of cognitive function (Au, Dale-McGrath, & Tierney, 2017; Narazaki et al., 2013; Overton, Pihlsgård, & Elmståhl, 2019). Further research is required to determine the association between gender and cognitive function.

Educational level is a crucial factor influencing the problem of cognitive function in older adults. First, in terms of cognitive protection, higher levels of education are often associated with a reduced risk of cognitive function problems, making it a protective factor for the problem of cognitive function (Horvat et al., 2014; Dause & Kirby, 2019; Clouston et al., 2020; Shen et al., 2021). Additionally, longitudinal studies have indicated that individuals with higher levels of education are more likely to maintain relatively intact cognitive function late in life (Livingston et al., 2017). However, one study suggested a weak relationship between education level and age-related cognitive function problems (Lövdén et al., 2020). Second, education level is intertwined with the concept of cognitive reserve. Cognitive reserve refers to the flexibility and adaptability of the brain cultivated through education and cognitive stimulation (Pettigrew & Soldan, 2019). Individuals with higher levels of education may possess more cognitive reserves, enabling them to better withstand the impact of cognitive function problems (Stern, 2012), and even prevent cognitive decline after a stroke (Contador et al., 2023).

Economic status is a relevant factor influencing the problem of cognitive function in older adults. Adequate economic wellbeing has become widespread and is a protective factor for cognitive function in older adults (Wang et al., 2023). Additionally, another study examined the potential

impact of socioeconomic status on post-stroke cognitive function problems, indicating that stroke survivors with lower socioeconomic status are at a significantly higher risk of post-stroke cognitive function problems (Tian et al., 2024). However, Wörn et al. (2017) suggested that community socioeconomic status did not independently affect cognitive function in older adults in the Netherlands.

Many studies have reported that chronic diseases, such as hypertension, diabetes, cancer, and stroke, are risk factors for the problem of cognitive function in the older adults (Dao, Choi, & Freeby, 2023; Lo et al., 2022; Wei et al., 2018; Zúñiga Salazar et al., 2024; Treanor et al., 2016). One cross-sectional study showed an association between hypertension and the problem of cognitive function in older adults. In patients over 75 years old, hypertension and pulse pressure were predictors of cognitive decline (Wei et al., 2018). The cognitive domains most affected by hypertension were executive function, attention, and processing speed, particularly in patients with subcortical diseases (Wei et al., 2018; Zúñiga Salazar et al., 2024).

Diabetes is also a risk factor for mild the problem of cognitive function (Dao, Choi, & Freeby, 2023; Xue et al., 2019). Studies indicate that the duration of diabetes, accompanying vascular changes or related complications, hyperglycemia, and hypoglycemia may exacerbate the problem of cognitive function, exposing diabetic patients to a significantly increased risk of the problem of cognitive function (Dao, Choi, & Freeby, 2023). A systematic review and meta-analysis of 144 prospective studies found that diabetes increased the risk of the problem of cognitive

function (Xue et al., 2019). However, other studies have found no association between diabetes and the problem of cognitive function, even though long-term treatment may help reduce the risk of the problem of cognitive function (Momtaz et al., 2019).

Evidence suggests that up to 75% of cancer survivors experience the problem of cognitive function due to cancer treatment (Treanor et al., 2016). The problem of cognitive function may occur before or without cancer treatment (Casella et al., 2018).

One study has shown that cognitive function declines more rapidly in stroke patients than in non-stroke patients, with advanced age and recurrent stroke accounting for a significant portion of this decline (Lo et al., 2022). Specific impact mechanisms of different diseases and multimorbidities on the problem of cognitive function in older adults require further research.

Frailty is a significant factor influencing the problem of cognitive function in older adults. A study conducted in Canada indicated that frailty is an important risk factor for impaired cognitive function (Ward, Wallace, & Rockwood, 2021). Additionally, a systematic review by Vahedi et al. demonstrated that frail individuals had significantly lower MMSE scores than robust and pre-frail populations, with pre-frail individuals scoring significantly lower than robust individuals, highlighting a strong correlation between physical frailty and the problem of cognitive function (Vahedi et al., 2022). The results of the Tasmania Cognitive and Gait Study indicate that frailty is a significant factor in early the problem of cognitive function, and that measuring frailty can

help identify the risk of future cognitive function problems (Siejka et al., 2022).

Additionally, Nari et al. (2021) found an association between the frailty status transition and cognitive function. Over a two-year period, the rate of cognitive decline was the highest among the remaining frail individuals for males, while the transition from non-frail to frail status was significantly associated with the lowest cognitive function values among females. Based on the relationship between physical frailty and cognition, Chen et al. proposed the concept of physioognitive decline syndrome, characterized by concurrent motor and the problem of cognitive functions, without it becoming a disability or dementia (Chen & Arai, 2020).

Furthermore, different phenotypes of frailty have varying effects on cognitive function, with gait slowness having the closest relationship with cognitive problems. A ten-year longitudinal cohort study in Japan demonstrated specific clinical trajectories for each frailty phenotype, with gait slowness as a subtype associated with the problem of cognitive function (Huang et al., 2020). This association is primarily due to significant impairments in both non-memory and memory domains during frailty, with non-memory domain deficits (such as executive dysfunction) appearing earlier than memory deficits during the pre-frail stage (Wu et al., 2015). A study conducted in Italy reported a strong and significant correlation between Montreal Cognitive Assessment (MoCA) scores and the five-meter gait speed test in frail elderly individuals with diabetes and hypertension (Mone et al., 2022). Frailty and cognitive function share

common risk factors and mutually influence each other.

Recent studies have highlighted the intricate relationship between pain and the problem of cognitive function (Zhang et al., 2021). Chronic pain may lead to the problem of cognitive function, with headaches being associated with a higher risk of dementia (Wang et al., 2018). Clinical research has indicated a close correlation between pain and attention, memory, executive function, and information processing (Berryman et al., 2014; Mazza, Frot, & Rey, 2018). Simultaneously, prolonged pain states may alter brain structure and function, affecting cognitive abilities such as learning and memory, thereby contributing to memory decline in older adults (Bell, Franz, & Kremen, 2022; Whitlock et al., 2017). However, some studies have suggested that persistent pain is not associated with the occurrence of the problem of cognitive function and is unrelated to cognitive domains such as attention, memory, and executive function (de Aguiar et al., 2020; van der Leeuw et al., 2018).

Recent research has emphasized the intricate interplay between falls and the problem of cognitive function in older adults. Falls are common among older adults, with higher incidence and prevalence rates observed in those with cognitive functional problems (Burton et al., 2022; Kim, 2020; Montero-Odasso & Speechley, 2018), which are primarily attributed to cognitive decline and related neurological sequelae. Cognitive functional problems can affect the perception of the surrounding environment, thereby affecting balance and coordination, further increasing the risk of falls (Liu-Ambrose et al., 2019). Additionally, older adults with a history of falls are more likely to experience the problem

of cognitive function (Paul et al., 2014; Trevisan et al., 2021), which may increase after two or more falls (Trevisan et al., 2021), possibly because of the effects of falls-induced brain trauma or a vicious cycle (Callisaya et al., 2016).

Activities of Daily Living (ADL) capacity is an important health indicator reflecting the independent living abilities of older adults (Pashmdarfard & Azad, 2020). Numerous studies have indicated that limitations in ADL are risk factors for impaired the problem of cognitive function in older adults (Giebel, Sutcliffe, & Challis, 2015; He et al., 2023). Additionally, research suggests that physical exercise plays a crucial role in the relationship between ADL and cognitive function (D'Aurizio et al., 2023; Song & Park, 2022). Specifically, declines in ADL abilities such as dressing, bathing, eating, and toileting may be associated with reduced physical activity (D'Aurizio et al., 2023), with physical exercise being considered a protective factor for overall cognitive function in older adults. Older adults who do not engage in physical exercise are at an increased risk of subsequent the problem of cognitive function (Song & Park, 2022).

The relationship between weight changes and cognitive function is complex. Some studies have found that older adults in the early stages of the problem of cognitive function may experience weight decline, which could be due to cognitive decline affecting eating behavior or appetite (Asaduroglu et al., 2015; Eymundsdottir et al., 2021). Similarly, another study found that individuals with low body mass index may be at risk of the problem of cognitive function, while those with high body

mass index may serve a protective factor against cognitive function problems in older adults (Kim, Choi, & Lyu, 2020). However, other studies have proposed the opposite view, suggesting that weight gain may be associated with a decline in cognitive function (Lo et al., 2012; Virtanen et al., 2013). Borda et al. (2021) found no significant association between weight change and cognition in elderly individuals in Colombia and South Korea.

In terms of psychological factors, depression, psychological resilience, and anxiety have been studied in relation to the problem of cognitive function in older adults.

Depression is a significant factor affecting cognitive function in older adults. Current research indicates a correlation between depression and cognitive function, with higher levels of depression associated with poorer cognitive function outcomes (Kim, 2022; Kim, 2019). Shin (2021) and Baek & Yoon (2023) have identified depression as a risk factor for the problem of cognitive function. Furthermore, it has also been shown that depressive symptoms in older adults have a long-term impact, cumulatively affecting cognitive function adversely (Kim, Oh, & Huh, 2023). They also found that depressed older adults are at a significantly higher risk of developing MCI compared to non-depressed older adults (Vloeberghs et al., 2018).

Psychological resilience may be a relevant factor affecting cognitive function in older adults. Jung et al. (2021) found that psychological resilience is associated with cognitive function, with better psychological resilience linked to better cognitive function status.

Currently, research on the impact of anxiety on cognitive function is

limited. Some studies have suggested that anxiety levels in older adults are associated with cognitive function, with higher anxiety levels linked to poorer cognitive function status and an increased risk of cognitive function problems (Freire et al., 2017). Further research is required to elucidate this hypothesis.

Some studies have suggested that dietary nutrition is associated with the problem of cognitive function in older adults. Improving the body's nutritional status and specific nutrient levels may help alleviate and improve cognitive function (Solfrizzi et al., 2017). Specifically, consuming moderate amounts of red meat, and regularly eating fruits, vegetables, fish, and other seafood can increase the intake of polyunsaturated fatty acids to a certain extent, raise the levels of lipophilic antioxidants in the plasma, and reduce the risk of cognitive function problems for older adults (Xu et al., 2015; Qin et al., 2014).

2) Interpersonal level

The close association between cognitive function in older adults and marital status has received significant research attention and sparked extensive discussion. Marital status is a frequently overlooked social risk factor with crucial implications for cognitive function (Shen et al., 2022; Nakahori et al., 2021). The relationship between cognitive function in late life and marital status is influenced by various factors, including gender, marital quality, and individual socioeconomic and health status (Kim & Kwon, 2023; Liu, Zhang, & Zhang, 2021). Lyu et al. (2019) emphasized

the adverse longitudinal impact of widowhood on late-life cognitive function among older adults. Gender plays a key role in this relationship, and studies from different countries and regions have demonstrated heterogeneity (Kim, 2022; Jennings et al., 2022). Specifically, research indicates that unmarried status is associated with an increased risk of the problem of cognitive function (Kim, 2022). In contrast, among females, the impact of unmarried status on cognitive function is relatively minor, whereas widowhood is correlated with the problem of cognitive function (Xu et al., 2021). This underscores the gender differences in the relationship between marital status and cognitive function.

The relationship between end-of-life cognitive function and the number of living children is complex and diverse. Some researchers have found that there is a curvilinear relationship between the number of children and cognitive function, whereby parents' cognitive function reaches an optimal state within a certain range of offspring, whereas parents with too many or too few children may face risks to cognitive function (Bonsang & Skirbekk, 2022; Zhang & Fletcher, 2021). Specifically, compared with parents with two children, those with three or more children may experience more severe the problem of cognitive function in later life (Bonsang & Skirbekk, 2022). The study found that having at least one living adult child was associated with a lower risk of the problem of cognitive function in older adults, and compared to older adults with no children, older adults with three or more children and older adults with adult daughters had a significantly lower risk of the

problem of cognitive function (Zhang & Fletcher, 2021).

Social relationships are relevant factors that influence the problem of cognitive function in older adults. Research has found that older adults with better social relationships tend to have better cognitive functioning, indicating that good social relationships serve as protective factors for cognitive function in community-dwelling older adults (Kelly et al., 2017; Kim & Lee, 2019). However, a recent meta-analysis by Cunha et al. suggests that formal social participation may improve cognitive abilities in older adults, although the evidence is low (Cunha et al., 2024). Therefore, further high-quality research is required to better understand the relationship between social relationships and cognitive function.

Physical exercise is a relevant factor influencing cognitive function in older adults. This prevailing view suggests that physical exercise positively affects cognitive function in older adults (Kirk-Sanchez & McGough, 2014). After controlling for sociodemographic factors, Vancampfort et al. (2017) suggest that physical exercise serves as a protective factor for cognitive function in older adults. Jonasson et al. (2017) and Hindin et al. (2012) found that aerobic exercise improved cognitive function in older adults. However, further research is required to determine whether non-aerobic exercises such as walking provide comparable protection and improvement in cognitive function in older adults.

The relationship between smoking, alcohol consumption, and cognitive function in older adults remains controversial. Studies have indicated that a considerable proportion of Alzheimer's disease cases worldwide may be

associated with smoking behavior (Livingston et al., 2017). A longitudinal study conducted in the United States found that smoking significantly increased the risk of dementia over a period of 12 years (Deal et al., 2020). Additionally, research has highlighted that passive smoking increases the risk of cognitive function problems in older adults (He et al., 2020; Kim et al., 2022; Rajczyk, Ferketich, & Wing, 2023). Smoking and alcohol consumption are considered risk factors for the problem of cognitive function in older adults, and this risk increases with the duration and frequency of these behaviors (Mons et al., 2013). However, conflicting findings have been reported. Some studies have shown no significant statistical differences in cognitive function impairment among older adults based on alcohol consumption or smoking history (Cataldo, Prochaska, & Glantz, 2010). Furthermore, some surveys have suggested that moderate alcohol intake may be beneficial for cognitive health (Akagi et al., 2022; Zhang et al., 2020; Rajczyk, Ferketich, & Wing, 2023). Nevertheless, excessive alcohol consumption remains a risk factor for cognitive function and dementia problems, thereby highlighting the importance of moderate (light to moderate) alcohol consumption (Topiwala & Ebmeier, 2018; Jeon et al., 2023).

3) Organizational & Community level

The problem of cognitive function in older adults was directly associated with the burden of healthcare costs. With advancing age, cognitive function often declines, necessitating more medical services and

care, leading to increased healthcare costs (Kim et al., 2018). Typically, family members bear the healthcare expenses for older adults, especially those requiring long-term care or specialized medical treatment (Barken, 2019). However, financially disadvantaged families may struggle to provide adequate medical support, limiting older adults' access to effective treatment and exacerbating cognitive function problems (Kumar et al., 2023; Lien & Huang, 2017; Suen & Thang, 2018; Veras et al., 2008). Therefore, the economic status of healthcare cost bearers significantly affects the problem of cognitive function in older adults. Additionally, when faced with exorbitant medical expenses or financial hardships (Kumar et al., 2023; Lu et al., 2022; Deardorff et al., 2019), the decisions of healthcare cost bearers can influence the cognitive function problems of terminally ill older adults. Particularly, considering that end-of-life care expenditure for critically ill older adults are highly concentrated and extend into the last month of life (Jo, Lee, & Kim, 2023; Kocot et al., 2024), economic pressures may further restrict older adults' access to necessary care and support, further impacting their cognitive function and overall quality of life.

Previous studies have indicated that hospitals are the most common place of death for older adults with the problem of cognitive function, while the number of deaths occurring at home has gradually decreased (Mai et al., 2018; Kim, 2022; Koyama et al., 2020; Perrels et al., 2014). Research across multiple countries involving patients with dementia has shown significant differences in the place of death. Most patients with dementia die in nursing homes, followed by hospitals and homes (Regier

et al., 2021; Dasch & Lenz, 2022; Dasch, Bausewein, & Feddersen, 2018). The findings of these studies emphasize the close relationship between the place of death and the problem of cognitive function, highlighting the differences in end-of-life care services across various countries and regions (Perrels et al., 2014).

Research on the relationship between cognitive function and place of residence encompasses data from various countries and regions examining the impact of residence on cognitive function from different perspectives. In general, urban residents have better cognitive function, while rural residents are more prone to the problem of cognitive function (Park et al., 2023; Weden et al., 2018; Xu et al., 2017). In terms of healthcare access and health inequalities, when cognitive problems occurred, urban residents were diagnosed and treated sooner than rural residents, indicating relatively higher rates of access to national services for this population, and suggesting geographic barriers to healthcare access at large (Park et al., 2023). A study exploring the long-term effects of rural-urban residency history on cognitive functioning found that early residence in rural areas was associated with poorer cognitive functioning in later life, even after adjusting for education and other relevant factors (Cassarino et al., 2016). Some studies suggests that socioeconomic factors play a significant role in rural-urban cognitive function disparities (Horvat et al., 2014), and factors such as education level, occupation, and income partially explain these differences (Xu et al., 2017; Glauber, 2022). Early life residence has a persistent effect on late-life cognitive function, suggesting that rural-urban inequalities

experienced throughout one's life may be longitudinally associated with inequalities in cognitive health (Orsholits et al., 2022; Peterson et al., 2023).

4) Public policy level

Research on healthcare insurance not only reflects the economic status of beneficiaries but also involves healthcare utilization. Studies have demonstrated that factors such as pension benefits and medical insurance coverage are closely associated with the maintenance and decline of cognitive function (Peng, Burr, & Han, 2023; Willink et al., 2016). Specifically, medical insurance coverage is significantly associated with the risk of cognitive function problems (Peng, Burr, & Han, 2023). Further, medical insurance is closely related to the health status and the medical expenses of older adults (Willink et al., 2016).

The healthcare insurance system in South Korea differs from that of many other countries. South Korea has adopted a two-tier universal healthcare system covering all residents, namely, the Health Insurance and Medical Assistance Program (Kong & Kim, 2020; Kim, Seo & Kang, 2022). The Health Insurance is a wage-based premium insurance plan covering nearly all Koreans (Kong & Kim, 2020; Kim, Seo & Kang, 2022). The Medical Assistance Program is a government-subsidized public assistance program targeting the poor and medically vulnerable groups that belong to the lowest economic class in South Korea and mainly rely on financial support from the National Social Security Fund

(Kong & Kim, 2020; Kim, Seo & Kang, 2022). However, there is still a segment of the near-poor population in South Korea who are excluded from the Medical Assistance Program due to slightly higher incomes, and lack of coverage under the Health Insurance program, and are thus unable to fully utilize medical services and face high out-of-pocket expenses (Park, 2021; Kim & Jacobson, 2022). Studies have found that impoverished older adults receiving Medical Assistance Program may experience poorer health conditions earlier and may have more severe health conditions when diagnosed with the same diseases (Kim, Seo & Kang, 2022). In addition, older adults face numerous challenges in accessing medical services. Research has shown that the rate of unmet medical needs among older adults is 17.4%, with economic difficulties being the main reason, accounting for 9.2% (Kim et al., 2018). Therefore, when exploring healthcare utilization, health disparities, and poverty in older adults, studying the impact of healthcare insurance types on the problem of cognitive function in terminally ill older adults becomes particularly important.

III. Method

1. Design and data source

This cross-sectional and correlational study analyzed secondary data from a Korean older adults population survey data (Korean Longitudinal Study of Aging, KLoSA). The KLoSA is a large household micro survey conducted by the Longitudinal Aging Team Survey organized by the Korea Labor Research Institute and Korea Employment Information Research Institute. Since then, core interviews and a nationally representative follow-up survey, have been conducted every 2 years (except on Jeju Island), and exit interview has been conducted every 2 years for the deceased core interviewees. The use of computer-assisted personal interviews and the compensation and rewards provided after the completion of the survey increased the survey completion rate (Survey Employment, 2021).

The KLoSA research design included both cross-sectional and longitudinal components. The cross-sectional design involved a one-time survey that spanned different age groups to provide a comprehensive understanding of the instantaneous conditions of the aging population. Simultaneously, the longitudinal design tracked the same group of older adults at multiple time points, revealing their life changes and developmental trends. Utilizing a stratified cluster sampling method ensures the samples were representative. Initially, random sampling was conducted at the levels of urban and rural areas, followed by further

random selection through household registries to ensure the sample diversity. Weights were assigned to reduce the design effects caused by stratified sampling.

Regarding data collection, KLoSA employs various tools, including face-to-face individual interviews, survey questionnaires, and physical health examinations. Through these diverse data sources, detailed information is gathered on various aspects of the problem of cognitive function, such as physical health, psychological status, economic conditions, and social participation. This comprehensive and multilayered design and data collection approach enables the KLoSA to thoroughly investigate the living conditions and trends among older adults.

The KLoSA data comprise seven baseline surveys conducted from 2006 to 2018. A total of 10,254 adults aged >45 years (born in 1961 or earlier) completed the baseline assessments. By the seventh survey in 2018 a total of 9,510 core interview data and exit interview data were completed, of which the effective sample size for there was 7,491 including 6,940 core interview data and 551 exit interview data, with an effectiveness rate of 78.8%.

The core interview data were divided into seven parts. The first part included demographic characteristics, including age, gender, educational background, religious beliefs, work status, marital status, social activities and social relationship status. The second part was the status of family members, including the work, living, living and health status of their children, spouses, parents, brothers and sisters. The third part was the health status, including self-rated health, chronic diseases, health habits,

mental health and depressive symptoms, disability, health security and welfare use status, cognitive ability, physical ability, etc. The fourth part was the working conditions, including work type, working hours, job benefits, job satisfaction, job expectations, unemployment and job hunting, retirement reasons, etc. The fifth part was the income information, including work income, annuity income, social welfare, other income, etc. The sixth part was the family property status, including residential housing, real estate, financial and non-financial assets, heritage and gifts, liabilities, etc. The seventh part was the subjective expectations and feelings, including the judgment of the future economic conditions, life expectancy, living standards, government expectations, life satisfaction, etc.

The data for this study originated in 2008, with the KLoSA conducting biennial exit interviews to provide comprehensive information on deceased participants. When the death of the respondent was confirmed, the KLoSA exit survey was conducted as an interview with surrogate respondents of the decedents, such as family members or other acquaintances. Each data point includes the deceased individual's mortality status over the past two years and detailed characteristics of their circumstances and activities before death. The exit interview data covered respondent identities and death-related questions, encompassing information on the deceased individual's health, employment, inheritance, responsibilities, and so on. This study employed a longitudinal survey approach, primarily focusing on the lifespan and health status of the deceased participants. Data collection involved family members, relatives,

friends, and others associated with the deceased older adults. By systematically gathering mortality information and compiling data on various aspects such as social, economic, and health factors, this approach contributes to a deeper understanding of the health dynamics throughout the lifespan of older people and the factors influencing the risk of mortality.

The exit interview data from the 2008 to 2018 survey, including six KLoSA exit interviews, are shown in Figure 3. Since 2008, deaths have been reported at two-year intervals, and the deceased respondents' questionnaires began with the second survey in 2008, in which family members of the deceased subjects in the first basic survey were surveyed about the content of the situation prior to death, so that the deceased participants had both the core data from the last survey and the exit data from the current survey. The seventh follow-up survey of deceased patients was completed in 2018. The exit interview data for the Deceased Panel Survey were 187 in 2008, 309 in 2010, 327 in 2012, 438 in 2014, 403 in 2016, and 551 in 2018, for a combined sample size of 2,215 participants. The exclusion criteria were as follows: no cross-sectional weight (n=611), adults aged 65 years and younger (n=169), no age information (n=10), and deaths from other reasons, not from illness (n=210), and adults having dementia or memory impairment as a chronic disease (n=216). Finally, 999 people were included in the analysis. Survey data, questionnaires, and coding guidelines were obtained from the KLoSA network (<https://survey.keis.or.kr/klosa/klosaguide/List.jsp>).

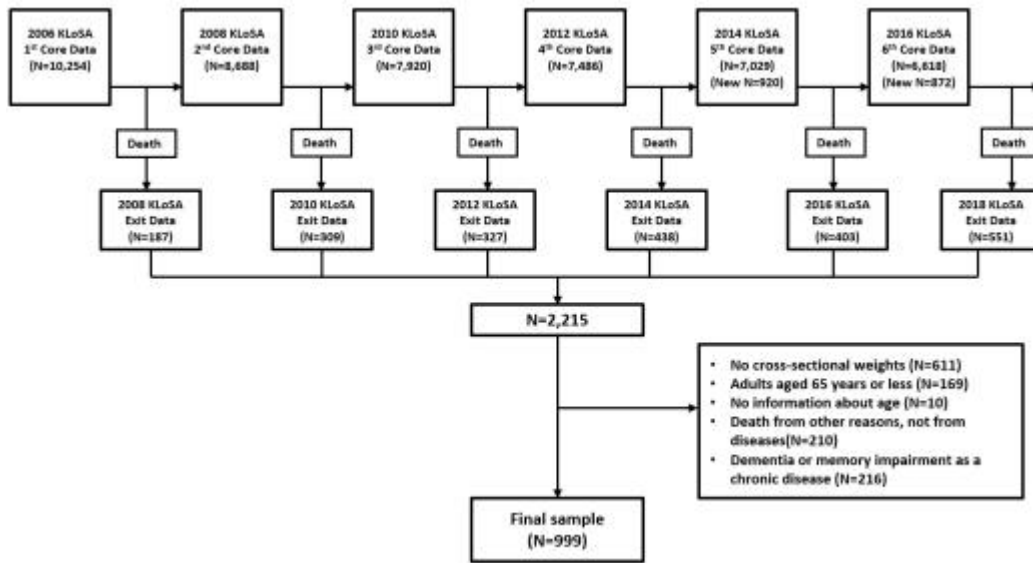


Fig 3. Sampling process for deceased older adults in 2008 - 2018

2. Inclusion and exclusion criteria

The inclusion criteria are as follows:

- a. Older adults over 65 years in South Korea.
- b. Older adults with data on cross-sectional weights from previous core interview data
- c. Older adults who died from illness.

The exclusion criteria are as follows:

- a. Older adults with no information about age.
- b. Older adults who have dementia or memory impairment as a chronic disease.

3. Definitions

Problem of cognitive function:

Theoretical definition: Cognitive function refers to the ability to acquire, process, and utilize information (Friedlander, 2014), encompassing memory, attention, language skills, problem-solving, and reasoning abilities. The problem of cognitive function in older adults at the end of life denotes a state wherein difficulties arise in acquiring, processing, and utilizing information due to declines in memory, attention, language skills, problem-solving, and other cognitive faculties.

Operational definition: In this study, the problem of cognitive function is defined as a status measured by the question, "Did the deceased have problems with memory (cognitive impairment) in the month before he/she died?"

End of life:

Theoretical definition: The theoretical definition of "end of life" refers to the final stage of an individual's existence, typically characterized by the imminent approach of death. This phase involves a decline in health, increasing frailty, and often requires specialized care to address the unique physical, emotional, and psychological needs of individuals facing the end of their lives (Schüttengruber, Halfens, & Lohrmann, 2022).

Operational definition: In this study, "End of life" is defined as the period in the last month before death, confirmed by family members or other acquaintances acting as proxies for the study participants.

4. Measurement tools

The study, based on the theoretical framework, delineated the influencing factors. Specific factors are listed in Table 1.

Table 1. Variables of this study

Variables	Category
Individual level	
Age at the time of death	Range: 66 - 108 years - 66-75 - 76-85 - 86≤
Gender	- Men - Women
Educational level	- Primary school or less - Middle school - High school or more
Chronic disease	- Yes - No
- Stroke	
- Hypertension	
- Diabetes	
- Cancer	
- Lung disease	
- Heart disease	
Pain during a year before death	- Yes - No
Falls experienced before death	- Yes - No
Dependence on ADL during 3 months before death	- 0~7 (The higher the score, the lower the ability to perform activities of daily living)
Interpersonal level	
Marital status	- Married - Divorced/separated/single/Bereaved
Number of living children	- 0 - 1 - 2 - 3 - 4≤
Smoking status after last core interview	- Non-smoker - Former smoker - Current smoker
Alcohol drinking after last core interview	- None - Former drinker - Current drinker
Organizational & Community level	
Main bearer of medical expenses	- Decedent - Spouse - Children/grandchildren and their spouses
Place of death	- Hospital - Assisted living facilities - Home
Residential area	- Rural - Town/Small city - Large city
Public policy level	
Type of insurance	- Health Insurance - Medical Assistance Program
Dependent variable	
Problem of cognitive function in the last month before death	- Yes - No

1) Individual level

Individual level included demographics and health-related factors. Demographics include age, gender, and educational level. Health-related factors encompass chronic disease, pain, falls, and activity of daily living (ADL). Age at the time of death was divided into three groups: 66-75, 76-84, 86≤. Gender was classified as men or women. Educational level was divided into three groups: primary school or less, middle school, high school or more. Chronic disease includes six diseases: stroke, hypertension, diabetes, cancer, lung disease, and heart disease. Pain during the year before death was divided into two groups: with no pain and pain. Falls experienced before death were divided into no fall and fall. ADL was assessed using a questionnaire composed of seven items: 1) changing clothes(socks, shoes, etc.); 2) washing face, brushing, and hair; 3) bathing; 4) eating; 5) standing up from the bedding and leaving the room; 6) using the toilet(from removing clothes to handling the toilet); and 7) seeking help for defecation. There are two options: "need help" and "no help"; the lowest score is 0 and the highest is 7. The higher the score, the lower the ability to perform activities of daily living.

2) Interpersonal level

The interpersonal level in this study included family-related factors and lifestyle factors. Family-related factors are marital status and

number of living children. Marital status was divided into two groups: married, divorced/separated/single/bereaved. The number of living children was divided into three groups: 0 - 1, 2 - 3, and 4 or more.

The lifestyle factors included two indicators: smoking status after the last core interview and alcohol status after the last core interview. Smoking and alcohol drinking status after the last core interview were divided into three groups: none, former, and current.

3) Organizational & Community level

The organizational and community levels included three indicators: main bearer of medical expenses, place of death, and residential area. The main bearer of medical expenses was divided into three groups: decedent, spouse, and children/grandchildren and their spouses. Place of death were divided into three groups: hospital, assisted living facilities, and home. The residential area was divided into three groups: rural, town/small city, and large city.

4) Public policy level

At the public policy level, it includes an indicator for "Type of insurance". The type of insurance was divided into two groups: Health Insurance and Medical Assistance Program.

5) Dependent variable

The dependent variable of this study was measured by one question using "Did the deceased have problems with memory (cognitive impairment) in the month before he/she died?" The answering options were "yes" and "no."

5. Statistical analyses

Statistical analyses were performed using IBM SPSS 26.0 statistical software package(IBM Corp., Armonk, NY, USA). Statistical significance was set at $p < .05$. Means and standard deviations were used to describe continuous variables, and numbers and percentages were used for categorical variables. The analysis was conducted without imputation when the amount of missing data was less than 5%, as the full case analysis can be used as the main analysis when the percentage of missing data is less than about 5% (Jakobsen et al., 2017).

Independent t-tests and chi-square tests with cross-sectional weights were used to identify significant factors related to the problem of cognitive function(weighted results). The problem of cognitive function as the dependent variable was binary; therefore, complex-sample logistic regression was conducted using cross-sectional weights in the final analyses to correct the differential probability of sample selection.

KLoSA is a crucial study designed to gain in-depth insights into the characteristics, trends, and influencing factors of the older adult

population in South Korea. Researchers employed complex sample design to ensure highly representative and generalizable research outcomes, primarily involving cross-sectional and longitudinal weights. This study is a cross-sectional investigation utilizing exit data, so cross-sectional weights were applied in the final analysis. Cross-sectional weights are primarily employed to correct biases from sample selection within a specific survey year. In this weighting design, researchers took into account the probability of participants being selected in a particular year, aiming to better reflect the proportions of different subgroups in the overall population.

The utilization of these weights ensures that cross-sectional data more accurately represent the overall characteristics of the older adults population in South Korea, mitigating biases caused by sample selection. The use of cross-sectional weights enables researchers to better understand the current status of the older adults population when analyzing data for specific years.

6. Research ethics

The KLoSA data were approved by the state under Article 18 of the Statistics Act (approval number: 33602) after obtaining verbal consent from the study participants. As the KLoSA data are anonymous and released to the public for scientific research, the study does not require further ethical approval from the Institutional Review Board, according to Section 15.2 of the Korean Bioethics and Safety Act.

Anonymized KLoSA data are available to the public on the survey website and can be downloaded. Therefore, this study did not harm the participants, and their anonymity and confidentiality were guaranteed. All participants provided written informed consent. An exempt status was obtained from the Ethics Committee of Sungshin Women's University (IRB Number: SSWUIRB-2022-059) as it used publicly available de-identified data.

IV. Results

1. Characteristics of the study subjects

Among the subjects, the youngest age at the time of death was 66 years and the oldest 108 years, and the mean age of death was 80.17 ± 7.41 years in the unweighted results. The specific frequency analysis results are shown in Table 2.

At the individual level, regarding the age at the time of death, 283(28.3%) people were aged 66 - 75 years, 478(48.0%) died aged 76 - 85 years, and 237(23.7%) died aged 86 years and older. Regarding gender, 419(41.9%) were woman and 580(58.1%) were man. Regarding education level aspect, 716(71.7%) were primary school or less, 113(11.3%) were middle school, 170(17.0%) were high school or more. Regarding disease, 163(16.3%) had a stroke, 280(28.0%) had hypertension, 180(18.0%) had diabetes, 254(25.4%) had cancer, 145(14.5%) had lung disease, 171(17.1%) had heart disease, 386(38.7%) had pain experienced, and 128(12.8%) had fall experienced. The score of dependence of ADL in the 3 months before death was 4.14 ± 3.17 .

At the interpersonal level, regarding marital status, 628 people(62.9%) were married and 371(37.1%) were divorced/separated/single/bereaved. In terms of the number of living children, 67(6.7%) had 0-1, 361(36.2%) had 2 - 3 students, and 570(57.1%) had four or more. Regarding smoking status, the majority do not smoke, accounting for 579 people(58.0%), former smokers accounted for 291 people(29.1%), and current smokers

were 129 people(12.9%). Regarding alcohol drinking, non-drinkers accounted for 528 people (52.9%), former drinkers numbered 294 people (29.4%), while current drinkers were 177 people (17.7%).

At the Organizational & Community level, regarding main bearer of medical expenses before death, 180 people (18.3%) were the main decedent, 138(14.1%) were spouses, and 664(67.6%) were the children/grandchildren and their spouses. Regarding place of death, hospital accounted for 684 people(68.5%), assisted living facilities accounted for 70 people(7.0%), home accounted for 235 people (23.5%). Regarding residential area, 371(37.2%) lived in large cities, 301(30.1%) in town/small cities, and the rural population was 327(30.1%).

At the public policy level, regarding the type of insurance, Health Insurance accounted for 886(89.6%) and Medical Assistance Program accounted for 100(10.1%).

Table 2. Characteristics of the study subjects (unweighted results)

(N=999)

Variable	Total	Missing data
	N(%) or Mean±SD	N(%)
Individual level		
Age at the time of death (years)	80.17 ± 7.41 (Range: 66-108)	0(0.0)
66 - 75	283 (28.3)	
76 - 85	479 (48.0)	
86 ≤	237 (23.7)	
Gender		0(0.0)
Woman	419 (41.9)	
Man	580 (58.1)	
Educational level		0(0.0)
Primary school or less	716 (71.7)	
Middle school	113 (11.3)	
High school or more	170 (17.0)	
Stroke		0(0.0)
Yes	163 (16.3)	
No	836 (83.7)	
Hypertension		0(0.0)
Yes	280(28.0)	
No	719(72.0)	
Diabetes		0(0.0)
Yes	180(18.0)	
No	819(82.0)	
Cancer		0(0.0)
Yes	254 (25.4)	
No	745 (74.6)	
Lung disease		0(0.0)
Yes	145 (14.5)	
No	854 (85.5)	
Heart disease		0(0.0)
Yes	171 (17.1)	
No	828 (82.9)	
Pain experienced during the year before death		2(0.2)
Yes	386 (38.7)	
No	611 (61.3)	

Table 2. Continued

Variable	Total	Missing data
	N(%) or Mean±SD	N(%)
Fall experienced before death		2(0.2)
Yes	128 (12.8)	
No	87.0 (87.2)	
Dependence of ADL during 3 months before death (range: 0-7)	4.14 ± 3.17	3(0.3)
Interpersonal level		
Marital status		0(0.0)
Married	628 (62.9)	
Divorced/separated/single/bereaved	371 (37.1)	
Number of living children		1(0.1)
0 - 1	67 (6.7)	
2 - 3	361 (36.2)	
4 ≤	570 (57.1)	
Smoking status at the core data		0(0.0)
Non-smoker	579 (58.0)	
Former smoker	291 (29.1)	
Current smoker	129 (12.9)	
Alcohol drinking at the core data		0(0.0)
None	528 (52.9)	
Former drinker	294 (29.4)	
Current drinker	177 (17.7)	
Organizational & Community level		
Main bearer of medical expenses		17(1.7)
Decedent	180 (18.3)	
Spouse	138 (14.1)	
Children/grand children and their spouses	664 (67.6)	
Place of death		10(1.0)
Hospital	684 (68.5)	
Assisted living facilities	70 (7.0)	
Home	235 (23.5)	
Residential area		0(0.0)
Rural	327 (32.7)	
Town/Small city	301 (30.1)	
Large city	371 (37.2)	
Public policy level		
Type of insurance		13(1.3)
Health Insurance	886 (89.9)	
Medical Assistance Program	100 (10.1)	

Note. SD=standard deviation; ADL=activities of daily living (the higher the score, the lower the ability to perform ADL)

2. Differences in the problem of cognitive function according to the characteristics of the study participants (weighted results)

The detailed outcomes of the complex weighted estimation are presented below and in Table 3 and 4. A quarter of older adults (24.5%) experienced the problem of cognitive function. In the 2008 exit data, 27.1% had a problem of cognitive function; 28.2% had a problem of cognitive function in 2010; 28.2% had a problem of cognitive function in 2012; 24.7% had a problem of cognitive function in 2014; 24.7% had a problem of cognitive function in 2016; and 17.7% had a problem of cognitive function in 2018.

As shown in Table 4, the mean age at death was 79.45 ± 0.27 years. A significant difference was observed in the prevalence of cognitive function problems among different age groups ($\chi^2=19.485$, $p=0.001$). In the age group 86 or older, 28.4% experienced the problem of cognitive function, while 18.3% did not. In the age group 66 - 75 years, 22.0% experienced the problems, while 35.1% did not.

The prevalence of the problem of cognitive function in older adults with a history of stroke was 24.0% in the group experiencing the problem of cognitive function and 12.7% in the group not experiencing the problem of cognitive function ($\chi^2=18.034$, $p<0.001$). The prevalence of the problem of cognitive function in older adults with heart disease was 11.6% in the group experiencing the problem of cognitive function and 19.4% in the group not experiencing the problem of cognitive function

Table 3. The problem of cognitive function from 2008-2018 (weighted results)

Year of Exit data	Experiencing of the problem of cognitive function	
	No	Yes
	%	
Total	75.5	24.5
2008	72.9	27.1
2010	71.8	28.2
2012	71.8	28.2
2014	75.3	24.7
2016	75.3	24.7
2018	82.3	17.7

($\chi^2=7.861$, $p=0.012$). The prevalence of the problem of cognitive function in older adults who have experienced pain in the group experiencing the problem of cognitive function (52.9%) was higher than those in the group not experiencing the problem of cognitive function (35.2%), with a significant difference between the two groups ($\chi^2=24.152$, $p<0.001$). The prevalence of the problem of cognitive function in older adults who have experienced falls in the group experiencing the problem of cognitive function (22.0%) was higher than those in the group not experiencing the problem of cognitive function (9.6%), with a significant difference between the two groups ($\chi^2=25.473$, $p<0.001$). Results from ADL indicated a statistically significant difference in the dependence of ADL between older adults with and without the problem of cognitive function ($\chi^2=9.774$, $p<0.001$).

Regarding main bearer of medical expenses, there were significant differences among the three groups ($\chi^2=10.887$, $p=0.009$). The prevalence of the problem of cognitive function in older adults whose medical expenses were borne by children/grandchildren and their spouses was 73.7% in the group experiencing the problem of cognitive function and 65.2% in the group not experiencing the problem of cognitive function. The prevalence of the problem of cognitive function in older adults whose medical expenses were borned by themselves was 10.6% in the group experiencing the problem of cognitive function and 19.9% in the group not experiencing the problem of cognitive function.

Regarding place of death, there were significant differences among the three groups ($\chi^2=11.188$, $p=0.007$). The prevalence of the problem of

cognitive function in older adults who died at home was 18.4% in the group experiencing the problem of cognitive function and 24.7% in the group not experiencing the problem of cognitive function. The prevalence of the problem of cognitive function in older adults who died in assisted living facilities was 11.5% in the group experiencing the problem of cognitive function and 5.9% in the group not experiencing the problem of cognitive function. The prevalence of the problem of cognitive function in older adults who died in hospital was 70.1% in the group experiencing the problem of cognitive function and 69.4% in the group not experiencing the problem of cognitive function.

Regarding type of insurance, older adults with Medical Assistance Program in the group experiencing the problem of cognitive function (15.3%) were higher than those in the group not experiencing the problem of cognitive function (8.8%), and there were significant differences between the two groups ($\chi^2=8.285$, $p=0.017$).

Table 4. Differences in the problem of cognitive function according to the characteristics of the study samples (weighted results)

Variables	Total	Experiencing of the problem of cognitive function		t or χ^2 (p)
		No(75.5%)	Yes(24.5%)	
% or M±SE				
Individual level				
Age at the time of death(years)				
66 - 75	31.9	35.1	22.0	19.485
76 - 85	47.4	46.6	49.7	(.001)
86≤	20.7	18.3	28.4	
	79.45±.27	78.87±.30	81.26±.57	3.719(<.001)
Gender				
Woman	43.6	42.7	46.3	.943
Man	56.4	57.3	53.7	(.376)
Educational level				
Primary school or less	70.7	68.8	76.5	7.484
Middle school	11.6	13.1	7.1	(.055)
High school or more	17.7	18.1	16.4	
Stroke				
Yes	15.5	12.7	24.0	18.034
No	84.5	87.3	76.0	(<.001)
Hypertension				
Yes	28.0	27.8	28.8	.088
No	72.0	72.2	71.2	(.794)
Diabetes				
Yes	18.6	17.9	20.9	1.132
No	81.4	82.1	79.1	(.370)
Cancer				
Yes	26.0	26.2	25.5	.054
No	74.0	73.8	74.5	(.843)
Lung disease				
Yes	15.1	15.3	14.6	.067
No	84.9	84.7	85.4	(.833)
Heart disease				
Yes	17.5	19.4	11.6	7.861
No	82.5	80.6	88.4	(.012)
Pain experienced during the year before death				
Yes	39.6	35.2	52.9	24.152
No	60.4	64.8	47.1	(<.001)
Fall experienced before death				
Yes	12.6	9.6	22.0	25.473
No	87.4	90.4	78.0	(<.001)
Dependence of ADL during 3 months before death (range: 0-7)				
	4.18±.11	3.68±.13	5.71±.16	9.774
				(<.001)

Table 4. Continued

Variables	Total	Experiencing of the problem of cognitive function		t or χ^2 (p)
		No(75.5%) % or M±SE	Yes(24.5%) % or M±SE	
Interpersonal level				
Marital status				1.412
Married	61.4	62.4	58.2	(.286)
Divorced/separated/single /bereaved	38.6	37.6	41.8	
Number of living children				1.672
0 - 1	7.0	7.6	5.4	(.490)
2 - 3	37.9	38.2	37.1	
4 ≤	55.0	54.2	57.5	
Smoking status at the core data				5.921
Non-smoker	58.0	56.8	62.0	(.091)
Former smoker	28.9	28.7	29.4	
Current smoker	13.1	14.5	8.6	
Alcohol drinking at the core data				3.261
None	52.7	52.3	54.0	(.306)
Former drinker	29.9	29.2	32.4	
Current drinker	17.4	18.6	13.7	
Organizational & Community level				
Main bearer of medical expenses				10.887
Decedent	17.6	19.9	10.6	(.009)
Spouse	15.1	14.9	15.8	
Children/grand children and their spouses	67.3	65.2	73.7	
Place of death				11.188
Home	23.2	24.7	18.4	(.007)
Assisted living facilities	7.2	5.9	11.5	
Hospital	69.6	69.4	70.1	
Residential area				4.573
Rural	34.0	33.6	35.3	(.146)
Town/Small city	31.1	32.8	25.8	
Large city	34.9	33.6	38.9	
Public policy level				
Type of insurance				8.285
Health Insurance	89.5	91.2	84.7	(.017)
Medical Assistance Program	10.5	8.8	15.3	

Note. SE=standard error; ADL=activities of daily living (the higher the score, the lower the ability to perform ADL)

3. Factors influencing the problem of cognitive function

The results of the multivariate logistic regression analysis are shown in Table 5. In the multivariate logistic regression analysis, significant factors for the problem of cognitive function in older adults at the end of life included age at the time of death, stroke, falls experienced before death, dependence of ADL during 3 months before death, main bearer of medical expenses, and type of insurance. Gender, educational level, hypertension, diabetes, cancer, lung disease, heart disease, pain experienced during the year before death, marital status, number of living children, smoking status, alcohol status, place of death and residential area were not identified as significant influencing factors. The model explained 13.7% (Cox and Snell R^2) and 20.5% (Nagelkerke R^2) of the problem of cognitive function in older adults at the end of life. The model fit was satisfactory and significant ($F=4.096$, $p<0.001$).

Older adults aged 86 or more years were more likely to have the problem of cognitive function than those aged 66 - 75 years (adjusted odds ratio [AOR]=2.286; 95% confidence interval [CI]=1.308 - 3.996). Patients with stroke are more likely to experience the problem of cognitive function compared to those without a history of stroke (AOR=1.920, 95%CI=1.213 - 3.040). Older adults with a history of falls are more likely to experience the problem of cognitive function (AOR=1.899, 95%CI=1.147 - 3.146). In the last 3 months before death, the odds of the problem of cognitive function increases with higher ADL dependence (AOR=1.192, 95%CI=1.116 - 1.274). Older adults whose medical expenses

were borne by children/grandchildren and their spouses had higher odds of the problem of cognitive function compared to those whose expenses were covered by the decedent (AOR=1.699, 95%CI=1.007 - 2.868). For the type of insurance, older adults with Medical Assistance Program had higher odds of the problem of cognitive function compared to those with Health Insurance (AOR=1.933, 95%CI=1.076 - 3.471).

Table 5. Factors associated with the problem of cognitive function before death

	AOR	95% CI
Individual level		
Age at the time of death (years)		
66 - 75	1 (Reference)	
76 - 85	1.608	0.994-2.600
86 ≤	2.286*	1.308-3.996
Gender		
Woman	1 (Reference)	
Man	1.255	0.724-2.175
Educational level		
Primary school or less	1 (Reference)	
Middle school	0.603	0.309-1.179
High school or more	0.869	0.519-1.457
Stroke		
No	1 (Reference)	
Yes	1.920*	1.213-3.040
Hypertension		
No	1 (Reference)	
Yes	0.914	0.598-1.396
Diabetes		
No	1 (Reference)	
Yes	1.101	0.677-1.792
Cancer		
No	1 (Reference)	
Yes	1.135	0.700-1.842
Lung disease		
No	1 (Reference)	
Yes	0.767	0.438-1.342
Heart disease		
No	1 (Reference)	
Yes	0.695	0.398-1.215
Pain experienced during the year before death		
No	1 (Reference)	
Yes	1.417	0.966-2.078
Fall experienced before death		
No	1 (Reference)	
Yes	1.899*	1.147-3.146
Dependence of ADL during 3 months before death (range: 0-7)		
	1.192*	1.116-1.274

Note. AOR, adjusted odds ratio; CI, confidence interval; ADL: activities of daily living(the higher the score, the lower the ability to perform ADL)

* $p < .05$

Table 5. Continued

	AOR	95% CI
Interpersonal level		
Marital status		
Married	1 (Reference)	
Divorced/separated/single/bereaved	1.041	0.626-1.732
Number of living children		
0 - 1	1 (Reference)	
2 - 3	2.126	0.960-4.707
4 ≤	1.820	0.838-3.953
Smoking status at the core data		
Non-smoker	1 (Reference)	
Former smoker	0.829	0.498-1.381
Current smoker	0.660	0.347-1.254
Alcohol drinking at the core data		
None	1 (Reference)	
Former drinker	1.012	0.613-1.670
Current drinker	0.897	0.490-1.643
Organizational & Community level		
Main bearer of medical expenses		
Decedent	1 (Reference)	
Spouse	1.831	0.930-3.606
Children/grand children and their spouses	1.699*	1.007-2.868
Place of death		
Home	1 (Reference)	
Assisted living facilities	1.324	0.855-2.050
Hospital	1.698	0.847-3.396
Residential area		
Rural	1 (Reference)	
Town/Small city	0.814	0.516-1.283
Large city	1.179	0.762-1.824
Public policy level		
Type of insurance		
Health Insurance	1 (Reference)	
Medical Assistance Program	1.933*	1.076-3.471
		Cox & Snell=.137, Nagelkerke=.205
		Wald F=4.096, p<0.001

Note. AOR, adjusted odds ratio; CI, confidence interval; ADL: activities of daily living(the higher the score, the lower the ability to perform ADL)

* $p < .05$

V. Discussion

This study investigated to identify factors influencing the problem of cognitive function in the last month before death in the older adults aged 65 years using data of KLoSA between 2008 and 2018. The prevalence of the problem of cognitive function was 24.5%, and the significant factors were age at the time of death, stroke, falls experienced before death, dependence of ADL during 3 months before death, main bearer of medical expenses, and type of insurance. This study focuses on personalized and multi-level intervention approaches for the problem of cognitive function at the end of life to better meet the needs of terminally ill older adults at the individual, interpersonal, community, and public policy levels based on the Health Ecological Model.

1. The problem of cognitive function in older adults at the end of life

The prevalence of the problem of cognitive function in older adults aged 65 or older was 24.5% based on KLoSA data from 2008 - 2018. The prevalence of the problem of cognitive function increased with age: 22.0% in the age group of 66-75 years, 49.7% in the age group of 76-85 years, and 28.4% in the age group of 86 years and above. Previous studies have defined older adults as 50+, 60+, or 65+, analyzing different age groups. These studies have primarily focused on the prevalence of dementia and mild cognitive impairment among the population. However,

the current study primarily addresses the problem of cognitive function in older adults, excluding dementia and mild cognitive impairment. Therefore, making it difficult to compare directly with this study. In South Korea, various studies have been conducted to determine the prevalence of mild cognitive impairment. In a study, limited to Seoul and involving only 860 elderly individuals aged 65 and above, the prevalence of mild cognitive impairment was 26.3% among individuals aged 65–69 and 46.5% among those aged 85 and above (Choo et al., 2009). In a nationwide population-based study on dementia and mild cognitive impairment for individuals aged 65 and above, the prevalence of mild cognitive impairment was found to be 24.1%, approximately three times higher than the dementia prevalence rate (Kim et al., 2011). In a multi-center prospective cohort study in residents aged 60 and above, the prevalence of mild cognitive impairment was reported as 27.0% (Han et al., 2018). A recent study from 2008 and 2017 found mild cognitive impairment rates ranged from 25.3% to 26.2% (Suh et al., 2021).

The prevalence of cognitive problems varied globally. In the International Cohort Consortium of Memory Studies (Pais et al., 2020), mild cognitive impairment rates in adults aged 50 and above ranged from 5.1% to 41% (median prevalence rate of 19.0%) in 11 studies in Europe, North America, South America, Asia, Africa, Australia (Pais et al., 2020).

The study results aligned with prior previous research on mild cognitive impairment and dementia in Korea (Choo et al., 2009; Kim et al., 2011; Han et al., 2018; Suh et al., 2021), slightly higher than previous

global studies (Sachdev et al., 2015; Pais et al., 2020). This may be attributed to the study population being older adults in the last month of life who may have severe conditions and symptoms. However, the measurement of cognitive function in this study utilized simple yes/no questions, making it challenging to directly compare with previous research that employed more reliable and valid tools such as the MMSE, and required caution in interpretation.

Using six waves of exit data from 2008 to 2018 means introduces a significant 12-year difference in participants' time of death, potentially causing data bias due to varied spans between deaths. Several steps can be taken to address this issue in future researchs. Firstly, improving data accuracy to closely monitor participants' death times is advisable. Regularly tracking the health status and survival status can provide more precise information. It is also important to ensure that the researcher has a process in place to obtain death information from the National Statistics Portal with the subject's permission. Secondly, employing statistical techniques such as survival analysis to adjust for temporal differences in data analysis is recommended (Indrayan & Tripathi, 2022). This approach can more accurately evaluate the relationships and mitigate bias from temporal discrepancies.

2. Factors influencing the problem of cognitive function based on the Health Ecological Model

The Health Ecological Model indicates that the individual level is situated at the core layer of the model, exerting a direct impact on cognitive function, primarily encompassing individual demographics factors and health related factors. This study found that age at the time of death, stroke, falls experienced before death, and dependence of ADL during 3 months before death affect the cognitive function of older adults at the end of life older adults.

The results of this study indicate an increased prevalence of the problem of cognitive function among older adults at the end of life as age increases. This is consistent with previous research findings (Petersen et al., 2018; Park & Festini, 2017), where cognitive function tends to decline with age, particularly becoming more pronounced at the end of life. Specifically, individuals aged 86 and above are more likely to experience the problem of cognitive function compared to those aged between 66 to 75. This finding may be attributed to the increased prevalence of chronic diseases, physical discomfort, and declines in psychological and social adaptability among most older adults as they age, especially towards the end of life, accelerating cognitive function decline (Hu et al, 2021).

The results suggest that for older adults nearing the end of life, it is essential to discuss palliative care, late-stage care planning, creating supportive environments, and addressing cognitive decline while their

cognitive function is still intact with the older adults and their families. Palliative care includes managing symptoms such as pain and agitation (Hyden et al., 2020), providing emotional support to address anxiety, depression, and fear associated with the end-of-life stage (Furtado, 2020), and involving family members in care decisions to respect the older adult's wishes (Lee et al., 2018). Late-stage care planning involves documenting end-of-life care preferences through advance directives and planning, including "do not resuscitate" orders and preferences for life-sustaining treatments, and appointing a healthcare proxy to make medical decisions when the older adult is no longer able to ((Kim & Lee, 2020; Shin et al., 2016 ; Gotanda et al., 2022).

Creating supportive environments includes hospice care to provide a comfortable environment focusing on quality of life rather than cure, and home care services to allow the older adult to spend their final days in a familiar environment (Greenstein, Policzer, & Shaban, 2019). It also considering providing resources and respite care for caregivers to prevent burnout and ensure continued care for the older adult (Teno et al., 2019; O'Sullivan et al., 2021). Additionally, measures to address cognitive decline include maintaining consistent daily routines and surrounding the older adult with familiar things and people to reduce confusion and anxiety, and engaging in activities that stimulate memory and cognitive function (Bainbridge & Seow, 2018; Gómez-Soria et al., 2023).

Therefore, ensuring dignity for older adults with cognitive function problems at the end of life requires a comprehensive and compassionate approach. For older adults nearing the end of life, the focus is on

comfort, palliative care, maintaining familiar environments, and strong social support. They also benefit from comprehensive advance care planning and involvement in medical proxy decisions to respect their end-of-life wishes.

In this study, there is no gender difference in cognitive function impairment at the end of life, consistent with the findings of Au et al. (Au, Dale-McGrath, & Tierney, 2017; Overton, Pihlsgård, & Elmståhl, 2019). Several factors may contribute to the diminishing or disappearance of gender differences in cognitive function at the end of life. Some studies suggest with aging, women may be more susceptible to cognitive function impairment compared to men (Lee et al, 2023), However, as the end of life approaches, this gender difference may diminish or disappear (Lee et al, 2018; Lee et al, 2023). This shift could be attributed to the increased prevalence of age-related health challenges such as worsening chronic diseases and declining physical function at the end of life (Park & Festini, 2017; Petersen et al., 2018; Rook & Charles, 2017), which may have similarly affect cognitive function in both genders (Overton, Pihlsgård,Pierce-Gardner, & Elmstahl, 2019). Furthermore, the overall decline in cognitive function at the end of life may reduce the significance of gender differences (Rothwell et al.,2022).

Although gender does not significantly factor affecting cognitive function at the end of life in this study, given the significant increasing life expectancy for women in South Korea and their potentially greater need for care support and resources (Levine et al., 2021; Statistics Korea, 2023), further research is warranted. Establishing separate regular

cognitive assessment and monitoring mechanisms for men and women may be necessary in preparation for the ultra-longevity era.

This study indicates no significant correlation between educational level and the problem of cognitive function at the end of life, which is consistent with some previous research findings (Zahodne et al., 2011), but differing from others (Opdebeeck, Martyr, & Clare, 2016; Seyedsalehi et al., 2023). Physiological aging likely influences cognitive function, while educational level does not directly impact the physiological aging process (Deary et al., 2009). Therefore, even at the end of life, individuals with lower education levels may experience similar declines in cognitive function as those with higher levels of education.

Although individuals with higher levels of education may possess a greater cognitive reserve (Stern, 2012), defined as the brain's flexibility and adaptability cultivated through education and cognitive stimulation, this effect may diminish by the end of life. Consequently, educational disparities may have a diminished impact on the problem of cognitive function in older adults (Pettigrew & Soldan, 2019). Other factors at the end of life, such as disease burden, physical health status, and psychological well-being, may also significantly impact cognitive function performance (Cohen-Mansfield, Skornick-Bouchbinder, & Brill, 2018; Deary et al., 2009), diminishing the relative influence of lower educational levels.

In a study of hospice patients who were not diagnosed with the problem of cognitive function or clinically evident the problem of cognitive function (e.g., delirium, unresponsiveness), older adults with

advanced, life-threatening illnesses were more susceptible to problems of global cognitive functioning (Burton et al., 2022). Stroke as a chronic disease merged as a significant factors associated with cognitive function at the end of life. This study indicates that older adults who have experienced a stroke are more likely to develop the problem of cognitive function at the end of life compared to those who have not experienced a stroke, consistent with previous research (Lo et al., 2022). The significant impact of stroke on the problem of cognitive function may originate from its direct effects on brain structure and function (Sotelo et al., 2020).

Stroke is an acute event caused by the interruption of cerebral blood supply or the sudden rupture of blood vessels, leading to ischemia or bleeding in brain tissues, and resulting in neuronal damage (Murphy & Werring, 2020). This damage can cause to a sudden and significant decline in cognitive function, manifested as memory decline, diminished thinking ability, and lack of concentration (Einstad et al., 2021). Conversely, chronic diseases such as hypertension, diabetes, etc., do not directly affect brain structure or function but gradually affect various body systems through long-term metabolic abnormalities, vascular damage, or chronic inflammation (Yaffe et al., 2020). Although these chronic diseases can be associated with the problem of cognitive function, their impact accumulates gradually and is not as sudden and pronounced as stroke (Wei et al., 2018; Dao, Choi, & Freeby, 2023; Xue et al., 2019). Furthermore, stroke episodes may lead to other serious health problems such as paralysis and swallowing difficulties indirectly

affecting cognitive function (Thingstad et al., 2018). Therefore, when studying the problem of cognitive function at the end of life, it is essential to consider stroke's direct and indirect effects.

Based on the research findings, to ensure that older adults with cognitive function problems due to stroke can end their lives with dignity, the following measures can be taken: palliative care, late-stage care planning, creating supportive environments, and addressing cognitive decline at the end of life. Additionally, their unique needs must be addressed. Specific measures include using rehabilitation services such as speech and occupational therapy to meet the communication and daily activity needs (Schiavi et al., 2018). Furthermore, consideration should be given to older adults with swallowing difficulties or dietary restrictions, providing personalized diets to meet the nutritional needs of stroke survivors (Shimazu et al., 2021). To support daily activities and maintain independence, technologies and assistive devices such as reminder apps, automated medication dispensers, and communication aids can be used (Nauha et al., 2018). These measures aim to improve the quality of life and ensure comprehensive and dignified care in the final stages of life. Adopting patient-centered care measures to meet their unique needs is essential.

This study found that pain is not a significant predictor of the problem of cognitive function in older adults, consistent with previous research (de Aguiar et al., 2020; van der Leeuw et al., 2018). The lack of significant differences between cognitive function and pain at the end of life may be influenced by various factors. Firstly, at the end of life,

multiple complex physiological changes may obscure the direct relationship between cognitive function and pain (Cohen–Mansfield, Skornick–Bouchbinder, & Brill, 2018). Secondly, the widespread use of analgesic therapy in end-of-life care reduces pain perception, thereby diminishing the correlation between pain and cognitive function (Knopp–Sihota et al., 2022). Additionally, psychological factors play an important role. At the end of life, individuals may experience emotional fluctuations such as anxiety, depression, etc., which can affect the perception of pain and the assessment of cognitive function, making their relationship more complex or less apparent (Duan et al., 2024). While this study suggests that pain does not significantly impact the problem of cognitive function in older adults at the end of life, a study indicates a relationship between pain and cognitive function (Zhang et al., 2021). Therefore, future studies should include pain severity, frequency, and pain medication use to explore further the relationship between pain and the cognitive function of older adults at the end of life.

This study found that older adults at the end of life with a history of falls are more likely to experience problems of cognitive function, consistent with previous research findings (Paul et al., 2014; Montero–Odasso & Speechley, 2018; Burton et al., 2022; Kim, 2020). Falls can have multifaceted impacts on the cognitive function of older adults at the end of life. Firstly, falls may result in physical injuries such as head trauma or fractures, which affect the brain and cognitive function (Enderlin et al., 2015). Secondly, fall events can trigger fear and anxiety, disrupting cognitive function, including memory and learning abilities

(Kim, 2021). Additionally, falls may lead to reduced levels of activity, limiting social and daily activities, which could exacerbate cognitive decline (Dias et al., 2011). In summary, falls can exert both direct and indirect negative effects on the cognitive function of older adults at the end of life.

In addressing the significant impact of falls on the cognitive function of older adults at the end of life, specific nursing interventions should complement palliative care, late-stage care planning, creating supportive environments, and managing cognitive decline. These interventions can ensure that older adults can end their lives with dignity in a safe, comfortable environment. Firstly, environmental safety modifications should be conducted to eliminate hazards in the home and care environment (Flattum & Stevenson, 2020), such as loose carpets and clutter, and ensure flat, unobstructed floors.

Additionally, installing assistive devices, such as handrails and grab bars, can help maintain balance and stability. Secondly, using appropriate assistive tools is essential (Nauha et al., 2018). Providing walking aids such as walkers, walking frames, or wheelchairs can assist older adults with safe mobility. Simultaneously, installing fall-detection devices, ensures prompt assistance in case of a fall (Nauha et al., 2018). Providing personalized care plans are also crucial (Montagnini, Javier, & Ritchie, 2017), including collaboration with physical therapists to develop strength and balance training programs. Continuous monitoring and evaluation are essential measures (Tricco et al., 2017).

Daily assessing the cognitive and physical conditions of older adults at

the end of life, adjusting care plans accordingly, and conducting fall risk assessments are crucial (Tricco et al., 2017). Technological assistance, such as smart home devices like smart lighting controls, voice assistants, and remote monitoring systems, helps older adults perform daily activities safely (Majumder et al., 2017).

This study indicates that increased dependency on ADL in the 3 months before death is associated with increased the problem of cognitive function, consistent with previous study findings (Gracia-Garcia et al., 2021; He et al., 2023). Older adults at the end of life often face multiple health problems, such as chronic diseases (e.g., stroke) and physical decline (e.g., falls), directly affecting their ADL (Park & Festini, 2017; Petersen et al., 2018; Rook & Charles, 2017).

For older adults at the end of life with significant cognitive function challenges owing to activities of daily living (ADL), the following end-of-life care measures can ensure comfortably and dignity. Firstly, personalized ADL care plans should be developed (Montagnini, Javier, & Ritchie, 2017). Regular assessment of ADL capabilities allows for adjustments based on specific needs and abilities, creating personalized care plans (Tricco et al., 2017). Increasing nursing interventions gradually as autonomy is lost respects independence and dignity. Secondly, involving a multidisciplinary team, including physical therapists, occupational therapists, and speech-language pathologists, provides comprehensive support in both physical and cognitive aspects, ensuring effective care (Schwab-Farrell et al., 2024). To assist older adults with basic ADL, appropriate ADL assistive tools should be provided (Nauha et

al., 2018; Ganesan et al., 2019). These tools, including walkers, wheelchairs, riser chairs, and portable toilets, significantly improve their quality of life and independence. In the caregiving process, education and support for family caregivers are also essential (Khan et al., 2021). Offering caregiving training and organizing support groups help family caregivers learn professional caregiving skills and receive practical advice and emotional support.

This study indicates that marital status does not impact the problem of cognitive function in older adults at the end of life, contradicting previous research (Shen et al., 2022; Nakahori et al., 2021). Several factors might explain the discrepancy. Firstly, cognitive function at the end of life is influenced by various factors, including genetic factors, health status, and socioeconomic status (Park & Festini, 2017; Petersen et al., 2018; Rook & Charles, 2017). Therefore, a singular marital status may not significantly affect cognitive function performance. Secondly, gender may play an important role in the relationship between cognitive function and marital status (Kim, 2022; Jennings et al., 2022). However, this study also found no significant gender differences in cognitive function, potentially overlooking the true relationship between gender and cognitive function. Similarly, not considering marital quality could affect the interpretation of study results (Liu, Zhang, & Zhang, 2021). Marital quality might exert a more significant impact on cognitive function than marital status alone, as good marital quality can enhance social support and emotional satisfaction, thereby positively impacting cognitive function (Liu, Zhang, & Zhang, 2021).

This study found no significant difference in the number of lived children and the problem of cognitive function among older adults, contradicting previous research findings (Bonang & Skirbekk, 2022). The lack of significant differences may reflect the complexity of the relationship between cognitive function and the number of lived children. Various factors, including genetic factors, health conditions, lifestyle, and social support, influence cognitive function in the end-of-life phase (Cohen-Mansfield, Skornick-Bouchbinder, & Brill, 2018).

Adult children serve as crucial resources of support and care for older parents, which can benefit their cognitive health (Zhang & Fletcher, 2021). Therefore, other factors, such as the quality of the relationship, frequency of contact, and emotional and financial support, may have a more significant impact on cognitive function than the number of children (Kotwal et al., 2021; Min, Kim, & Min, 2023). Individual differences exist among older adults, with some being more sensitive to the impact of the number of children while others are more sensitive to other factors (Beeri et al., 2009). Furthermore, the impact of the number of children on cognitive function may be long-term and gradual rather than producing significant short-term differences (Read & Grundy, 2017).

This study found no significant difference between alcohol consumption and the problem of cognitive function, consistent with previous research findings (Siddiquee et al., 2020). However, some studies suggest that moderate alcohol consumption may protect cognitive function, especially in older adults (Zhang et al., 2020; Akagi et al., 2022). Possible interpretations of these results include: Firstly, older adults in the

end-of-life stage may already have severe health issues, including cardiovascular and neurological disease (Enguella & Harwood, 2019). Secondly, older adults at the end-of-life stage may adjust their health awareness and lifestyle, including quitting or reducing alcohol consumption, leading to a less significant association between alcohol consumption and cognitive function (Heger et al., 2019).

Regarding smoking status, the study found no significant effect on cognitive function, consistent with previous research (Livingston et al., 2017; Deal et al., 2020). This result may be influenced by multiple factors. Firstly, older adults at the end of life face various health problems such as sudden death, organ failure, and frailty, which can more directly and significantly impact the problem of cognitive function than smoking (Enguella & Harwood, 2019; Lunney et al., 2018). Conversely, the effects of smoking on cognitive function may manifest over a longer period, and during the relatively short end-of-life stage, significant differences may not be observed (Wu et al., 2019). Secondly, older adults at the end of life often adjust their health awareness and lifestyles, including quitting or reducing smoking (Heger et al., 2019). This adjustment may mitigate the potential impact of smoking on cognitive function, making the relationship less apparent.

This study found that older adults whose end-of-life medical expenses were borne by their children/grandchildren were more likely to experience the problem of cognitive function compared to those whose expenses were borne by the deceased, which aligns with previous research (Long et al., 2022; Kumar et al., 2023; Lu et al., 2022). Firstly,

as healthcare expenditures of the older adults tend to be concentrated in their last years of life, due to high healthcare costs, many cannot fully cover these expenses and rely on family for support (Jo, Lee & Kim, 2023; Kocot et al., 2024). Children/grandchildren may face economic and psychological burdens when taking on the responsibility of caring for and supporting the patient (Kumar et al., 2023; Lu et al., 2022; Deardorff et al., 2019) influencing the choice of therapies aimed at maintaining cognitive function in terminally ill older adults (Jo, Lee & Kim, 2023; Kocot et al., 2024).

Secondly, older adults whose medical expenses are borne by children/grandchildren and spouses may experience greater social support and family pressure (Sancho-Balsells et al., 2023). Although this support can alleviate psychological stress to some extent, excessive family pressure may also negatively impact their cognitive function (Kulshreshtha et al., 2023). Additionally, because older adults whose medical expenses are borne by children/grandchildren and spouses may rely more on family members for support and care, they may face more psychological and emotional stress (Sancho-Balsells et al., 2023). This excessive dependence may lead to reduced autonomy and self-worth, further affecting cognitive function (Zwar et al., 2022). In summary, older adults whose medical expenses are borne by children/grandchildren and spouses are more prone to the problem of cognitive function, potentially due to economic pressure, family pressure, and excessive dependence.

The problem of cognitive function significantly affects the perception of end-of-life older adults. Firstly, Family-centered Function-focused Care

(Fam-FFC) can be provided for end-of-life older adults and their families (Boltz et al., 2014). Fam-FFC is a medical care model that views family members as integral components of the medical process, prioritizing functional recovery and enhancing family involvement (Boltz et al., 2014). In Fam-FFC, family members are collaborative partners with the patient, engaging in care decisions and actively contributing to the patient's rehabilitation and quality of life. This approach underscores the health and functionality of the entire family system, rather than solely managing individual patient symptoms. Fam-FFC includes three main measures: environmental assessment/modification, staff education, and family/patient education, as well as partnership in care planning with post-acute follow-up. Results show that Fam-FFC's significantly improve patients' activities of daily living and walking ability, reducing the severity and duration of mental confusion. Additionally, family caregivers experience significant improvements in caregiving preparedness, with reduced anxiety and depression, indicating that Fam-FFC enhances their well-being and alleviates their psychological burden (Boltz et al., 2014).

In South Korea, where 70.1% of older adults who die in hospitals have cognitive function problems, and considering the profound family culture, family members typically play a crucial role in caring for older adults. Therefore, FAM-FFC proposes a series of comprehensive intervention measures.

Firstly, through environmental assessment and modification, the environment in both the home and hospital is improved to provide safe

and comfortable living spaces, along with necessary assistive devices (Flattum & Stevenson, 2020; Nauha et al., 2018). These measures aim to reduce the risk of falls and enhance older patients' independence and quality of life. Secondly, staff education includes training for nursing staff to enhance their awareness of and ability to address the problem of cognitive function and end-of-life care needs (Tatum & Mills, 2020). Training content covers the identification of cognitive function problems, communication skills, emotional management, pain management, and comfort care. Additionally, interdisciplinary teams composed of physicians, nurses, rehabilitation therapists, social workers, etc., are established to jointly develop and optimize care plans through regular discussions and collaboration (Furtado, 2020; Tatum & Mills, 2020). Lastly, through family and patient education and partnership in care planning, the caregiving abilities and psychological support of family members are strengthened (Furtado, 2020). Systematic training is provided for family members, covering disease management, caregiving skills, coping strategies, and psychological support, to help them better cope with behavioral changes and caregiving needs that older adults may experience (Boltz et al., 2014). Meanwhile, family members are encouraged to actively participate in care plan development and implementation, maintain close communication with the medical team, and ensure that the needs and preferences of older patients are fully considered, including pain management and life support measures, to ensure that patients receive dignified and comfortable care at the end of life (Ko et al., 2012).

Enhancing social support networks is crucial for older adults and their families (Ho et al., 2023). FAM-FFC can provide more comprehensive caregiving services by integrating community resources. Practical caregiving support and assistance can be provided to families through community rehabilitation centers, volunteer organizations, and other resources (Morris et al., 2017; Nassehi et al., 2024). FAM-FFC can collaborate with these resources to provide comprehensive caregiving services for older adults and families, including daily care, emotional support, and social engagement services.

Efficiency in caregiving services can also be enhanced using information technology. Developing and promoting smart health monitoring systems to monitor older adults' health status in real-time through wearable devices can help detect and address potential health problems promptly (Majumder et al., 2017). Utilizing video calls and online consultation platforms to provide remote medical consultation and psychological support services for older patients and families can strengthen their social support networks, thereby helping maintain older adults' cognitive function health (Kelly et al., 2017).

Additionally, providing economic assistance and insurance coverage is crucial to ensuring that older adults receive necessary medical and caregiving services before the end of life and alleviating the economic burden on medical expense bearers (Condelius & Andersson, 2015; Sohn et al., 2020). Especially for older adults whose medical expenses are borne by children, grandchildren, and spouses, additional economic assistance and medical insurance should be provided (Pyenson et al.,

2019). These measures not only help maintain older adults' cognitive function health but also alleviate the financial burden on families, ensuring that older adults receive the necessary support and care before the end of life.

This study found no significant association between the place of death and the problem of cognitive function in older adults at the end of life, differing from other research (Perrels et al., 2014). The study indicated that 70.1% of older adults with the problem of cognitive function died in hospitals, and 11.5% died in assisted living facilities, consistent with other findings (Reyniers et al., 2015; Dasch & Lenz, 2022; Dasch, Bausewein, & Feddersen, 2018). The lack of significant differences may be attributed to complex interactions of multiple factors.

First, older adults at the end of life typically require more specialized and intensive medical supervision and care, which hospitals usually provide with comprehensive medical facilities and professional care (Reyniers et al., 2015). Even if older adults have relatively good cognitive function, they may opt for healthcare facilities in their final moments due to the need for these medical services (Perrels et al., 2014). Secondly, concerning family preferences and medical choices, older adults and their families may have their own preferences for end-of-life medical care (Waller et al., 2020), which may not be influenced by cognitive function levels. For instance, some families may prefer to receive end-of-life care at home or in assisted living facilities, while others may lean towards hospital-based care (Pinto et al., 2023). Third, regarding patient transfers, individuals at the end of life may undergo

multiple transfers between healthcare settings, from hospitals to assisted living facilities or homes, which can complicate the association between the place of death and cognitive function (Perrels et al., 2014).

This study did not find a significant difference in the problem of cognitive function related to residential areas, which differs from conclusions drawn in some previous studies (Xu et al., 2018; Xu et al., 2017; Weden et al., 2018). While it may be commonly assumed that urban areas have more developed medical resources and health services, the differences between urban and rural areas do not always directly reflect the problem of cognitive function (Aljassim & Ostini, 2020). This suggests that variations in cognitive function problems may be influenced by more complex social and demographic factors rather than solely by inherent factors. Apart from healthcare facilities and services, other factors such as education level, social support networks, and economic status may also significantly impact the problem of cognitive function (Wang et al., 2023; Shen et al., 2021). Therefore, when explaining the differences in the problem of cognitive function between urban and rural areas, we need to consider a broader range of social background and demographic factors, rather than solely focusing on disparities in healthcare resources. This argument emphasizes the complexity of studying cognitive function problems and highlights the need to comprehensively consider multiple factors to better understand their relationship with residential area.

The findings of this study indicate that older adults enrolled in medical assistance programs are more likely to experience the problem of

cognitive function compared to those covered by health insurance, aligning with previous study findings (Peng, Burr, & Han, 2023; Willink et al., 2016; Ton et al., 2017). Several factors may contribute to the increased likelihood of the problem of cognitive function among older adults participating in Medical Assistance Programs. This study demonstrates that 15.3% of older adults with the problem of cognitive function have a Medical Assistance Program, possibly indicating near-poor and specific populations. Participants in Medical Assistance Programs are typically individuals facing economic challenges, potentially hindering their access to timely and quality healthcare services, including cognitive function assessment and treatment, thus exacerbating the risk of the problem of cognitive function (Jung & Ha, 2021; Kong & Kim, 2020). Medical Assistance Program may reflect healthcare utilization (health disparities) among older adults. Participants in these programs are more likely to have chronic diseases or other health problems for longer periods, potentially associated with the problem of cognitive function (Kim et al., 2020), and are reported to have more severe health conditions when diagnosed with the same chronic disease (Kim, Seo & Kang, 2022). Medical Assistance Program recipients require more care, treatment, and education, but economic poverty and difficulties in accessing healthcare (e.g., limited transportation, where they live, etc.) and timely access to appropriate healthcare may contribute to the problem of cognitive function in older adults (Choi, Nam, & Kim, 2019; Park, Lee, & Yim, 2023).

In South Korea, policies targeting low-income and special populations

include the Medical Assistance Program and various support mechanisms within the National Health Insurance (NHI) system. The Medical Assistance Program provides extensive medical coverage for the lowest-income individuals, significantly reducing out-of-pocket expenses. It ensures access to necessary medical services for those unable to afford NHI premiums, aiming to alleviate economic barriers and improve healthcare accessibility for the most vulnerable economic groups (Lee et al., 2020).

The Catastrophic Medical Expenses Support program, initiated in 2013, aims to assist families facing exceptionally high medical expenses, covering a significant portion of out-of-pocket costs for severe illnesses such as cancer, heart disease, and rare diseases. The program has expanded to include a wider range of conditions and provides financial aid based on household income levels. For example, in 2021, the program supported over 18,000 families, significantly reducing their financial burden (Jung & Lee, 2021). Near-poor populations, slightly above the poverty line, face significant economic difficulties and are unable to access the Medical Assistance Program. Research suggests that near-poor populations are more likely to encounter catastrophic medical expenditures compared to higher-income groups. Proposed policy adjustments include reducing NHI premiums and providing additional subsidies to better support these populations (Park, 2021). Policy interventions implemented by the South Korean government include reducing NHI premiums for low-income families, expanding coverage of various medical services, and introducing plans to ensure continuous

insurance coverage and medical services (Park, 2021). South Korea's policies regarding medical insurance for low-income and special populations aim to reduce out-of-pocket expenses and ensure continued access to medical services. Despite significant progress, ongoing adjustments and improvements are needed to fully meet the needs of these vulnerable groups.

3. Recommendations for research, practice, education, and health policy

Future research should comprehensively consider multiple important factors to deepen the understanding of what influences cognitive function problems in older adults at the end of life. Firstly, studies could incorporate psychological health factors, such as depression, anxiety, and mental stress, and collect relevant data using standardized psychological assessment tools to understand how psychological health status affects cognitive function (Kim, 2022; Freire et al., 2017).

Secondly, indicators assessing frailty status in older adults, such as Fried's frailty phenotype model, could be introduced to assess their impact on cognitive function, enhancing the understanding of frailty in eldercare (Fried et al., 2001). Research should also investigate the frequency and types of physical exercise during the end-of-life period, and their longitudinal impact on cognitive function using questionnaires and activity logs (Stubbs et al., 2017). Dietary habits can be studied similarly (Milte et al., 2019).

Additionally, assessing the impact of social support networks and social relationships on cognitive function is crucial, using tools such as social network analysis and social support scales (Fratiglioni et al., 2000). Finally, future research should meticulously document the timing of patient admission to care facilities to determine if these events occurred before or after the onset of cognitive function problems, aiding in establishing causal relationships (Bartfay, Bartfay, & Gorey, 2014).

Integrating these factors will provide a comprehensive understanding of the variables influencing cognitive function problems, offering evidence for optimizing elder care and policy-making.

Providing comprehensive social support for older adults at the end of life is nuanced encompassing medical, psychological, social, and spiritual aspects. Firstly, medical support is paramount, with palliative and end-of-life care aimed at alleviating pain and symptoms to enhance the quality of life (Tatum & Mills, 2020). These supports are delivered by interdisciplinary teams comprising physicians, nurses, social workers, and mental health professionals (Tatum & Mills, 2020).

Psychological support is equally indispensable. Professional counseling assists older adults in navigating emotional and psychological challenges, while resilience training enhances their coping abilities, mitigating feelings of loneliness and anxiety commonly experienced at the end of life (Furtado, 2020). In terms of social support, community resources are vital, with community care services ensuring that older adults receive adequate care at home, and support groups facilitating emotional communication and understanding (Ho et al., 2023). Spiritual support offers religious counseling, meditation, and other activities tailored to individual beliefs to provide inner peace and solace (Batstone, Bailey, & Hallett, 2020). End-of-life care includes life review, encouraging older adults to share their life stories, reflecting on the meaning and value of life, and strengthening family bonds (Kukla et al., 2022).

Personalized care plans respect individual wishes, ensuring autonomy, and advance directives guarantee preferences are honored during final

moments (Kim & Lee, 2020). This process requires concerted efforts from various sectors of society, including healthcare institutions, families, communities, and volunteers.

4. Limitations

This study had some limitations to be considered when interpreting these findings. First, the large sample cohort database is subject to recall bias as the data collection relied on proxy recall of the respondents' deaths. Second, several potential influencing factors are described, including economic status, frailty, weight changes, depression, psychological resilience, anxiety, social relationships, physical exercise, and dietary nutrition in the literature review. However, they were not included in the analysis due to the limitations of secondary data analysis. Future studies should include potential influencing factors related to the problem of cognitive function at the end of life.

Third, using six waves of exit data from 2008 to 2018 means there's a significant 12-year difference in the time of death among participants, potentially leading to data bias due to varying spans of time between deaths. To address this, future research could implement more frequent data collection, utilize statistical techniques like survival analysis to account for temporal differences, and adopt comprehensive data collection strategies to better understand relationships between variables.

Fourth, the relationship between cognitive function problems and place of death is complex and potentially bidirectional: cognitive function problems might influence the place of death, or the place of death might affect cognitive function problems. To determine the direction of this relationship, understanding the timing of hospital or nursing home admissions is crucial. However, a limitation of this study is its reliance

on secondary data, which does not include variables indicating whether patients were admitted to these facilities before the onset of cognitive function problems or shortly before death.

Finally, the measurement of the problem of cognitive function in this study relied solely on a binary yes/no question, specifically, "Did the deceased have problems with memory (cognitive impairment) in the month before he/she died?" Therefore, direct comparisons with studies utilizing tools with high reliability and validity for measuring cognitive function are challenging.

VI. Conclusion

The swift development of global population aging signifies that more the problem of cognitive function will face the end of life stage accompanied by a decline in cognitive function, thereby increasing the risk of problems in cognitive function. This study aims to investigate the problem of cognitive function of older adults and related factors in the last month of life. This study establishes a theoretical model for understanding the factors influencing the problem of cognitive function in older adults at the end of life, using the Health Ecological Model as the research framework.

In this cross-sectional and correlational study, the secondary data analysis used exit interview data from the 2008 to 2018 Korean Longitudinal Study of Aging survey. The study included older adults aged 65 and older who died of disease, and excluded those with dementia or memory impairment as a chronic disease. Complex-sample logistic regression was conducted using 999 older adults. Statistical analyses were performed using IBM SPSS 26.0 statistical software package. Statistical significance was set at $p < 0.05$.

Age at the time of death was $79.45 \pm .27$ years old, and 24.5% of older adults have the problem of cognitive function in the last month before death. Factors that are significant differences in the problem of cognitive function according to the characteristics of the study subjects are age at the time of death, stroke, heart disease, pain experienced during the year before death, fall experienced before death, dependence on ADL during 3

months before death, main bearer of medical expenses, place of death, and type of insurance.

In the multivariate logistic regression analysis, age at the time of death, stroke, fall experienced before death, dependence of ADL within 3 months before death, major medical expense bearers, and type of insurance were significant factors influencing the problem of cognitive function. The model explained 13.7% (Cox and Snell R^2) and 20.5% (Nagelkerke R^2) of the problem of cognitive function in older adults at the end of life. The fitting results of the model were satisfactory and significant ($F=4.096$, $p<0.001$).

At the individual level, for older adults, particularly those facing the problem of cognitive function at end-of-life, a comprehensive and compassionate care approach is necessary. This entails palliative care, which involves effectively managing symptoms and providing emotional support to alleviate pain and anxiety; end-of-life care planning, encompassing advance directives and medical proxies to ensure respect and implementation of the individual's end-of-life wishes; creating supportive environments, including providing comfortable care settings and home care services while offering resources and temporary care for caregivers; and addressing cognitive decline by maintaining consistent daily routines, providing familiar environments, and engaging in activities that stimulate cognitive function to alleviate confusion and anxiety. In summary, the focus for end-of-life older adults lies in comfort, palliative treatment, maintaining familiar environments, and robust social support, while also fully respecting and implementing their end-of-life wishes.

Providing comprehensive social support for older adults at the end of life is a multifaceted process. This support encompasses various aspects including medical, psychological, social, and spiritual dimensions. Medical support involves palliative care and end-of-life care aimed at alleviating symptoms and improving quality of life. A multidisciplinary team offers holistic nursing and psychological support to help older adults navigate their final days. Psychological support, through professional counseling and resilience training, mitigates feelings of loneliness and anxiety. Social support includes community nursing services and support groups, providing both care and emotional connection. Spiritual support provides solace based on individual religious beliefs and needs. End-of-life care encourages life review and strengthens connections with family. Personalized care plans respect individual preferences, ensuring autonomy and honoring medical directives. This entire process necessitates close collaboration among medical institutions, families, communities, and volunteers.

This study emphasizes personalized and multi-level intervention approaches for the problem of cognitive function at the end of life, aiming to meet the needs of terminally ill older adults at individual, interpersonal, community, and public policy levels based on the Health Ecological Model. Future research should develop more intensive intervention programs to mitigate the problem of cognitive function and improve the quality of life in older adults at the end of life.

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논문개요

목적: 이 연구는 사망 전 마지막 달의 노인의 인지 기능 문제에 영향을 미치는 요인을 조사하였다.

방법: 본 이차자료 연구에서는 2008년부터 2018년까지 진행된 한국 고령화연구패널조사의 자료를 사용하였다. 이 연구의 대상자는 질병으로 사망한 65세 이상 노인이며, 만성 질환으로 치매 또는 기억 장애가 있는 노인은 제외되었다. 최종 999명의 노인을 대상으로 복합 표본 로지스틱 회귀 분석을 실시하였다. 통계 분석은 IBM SPSS 26.0 통계 프로그램을 응용하여 수행되었다.

연구 결과: 노인의 사망 당시 연령은 79.45 ± 2.27 세였으며, 사망 전 마지막 달에 인지 기능에 문제가 있었던 노인은 24.5%였다. 다변량 로지스틱 회귀 분석에서는 사망 당시 연령, 뇌졸중, 사망 전 낙상 경험, 사망 전 3개월 이내 일상생활수행능력 의존도, 의료비 주 지불자, 의료보험 형태가 인지 기능 문제에 영향을 미치는 유의한 요인으로 나타났다. 이 모델은 말기 노인의 인지 기능 장애를 13.7%(Cox and Snell R^2), 20.5%(Nagelkerke R^2) 설명하였다. 모델의 적합도는 유의한 결과를 보였다($F=4.096$, $p<.001$).

결론: 본 연구 결과 사망 연령, 뇌졸중, 사망 전 낙상 경험, 사망 전 마지막 3개월 동안의 일상생활 활동 의존도, 의료비 주 지불자, 의료보험 형태가 생애 말기 노인의 인지 기능 문제에 유의미한 영향을 미친다고 나타났다. 본 연구의 결과를 바탕으로 향후 연구에서는 생애 말기 노인의 인지 기능 저하를 완화하고 노인의 삶의 질을 개선하기 위해 보다 집중적인 중재 프로그램을 개발할 수 있을 것이다.

키워드: 노인, 인지기능, 임종간호