


Gender-Specific Incidence and Predictors of Cognitive Impairment among Older Koreans: Findings from a 6-Year Prospective Cohort Study

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Objective This study investigated gender-specific incidence and predictors of cognitive impairment among community-dwelling older adults in South Korea.

Methods Using data from the 2006 and 2012 Korean Longitudinal Study of Ageing (KLoSA), 925 females and 834 males aged 65 and over without cognitive impairment at 2006 were analyzed separately. Cognitive impairment was measured based on the Korean version of the Mini-Mental State Exam (K-MMSE) normative score. Generalized Estimating Equations (GEE) was conducted to examine the predictors of cognitive impairment at 6-year follow up.

Results Incidence of cognitive impairment at 2012 was significantly higher for women (30.5%) than men (26.1%). GEE result showed that depression was significantly associated with cognitive impairment for both genders (female: OR=2.26, 95% CI=1.63–3.12; male: OR=3.26, 95% CI=2.19–4.83). Having IADL limitations (OR=1.15, 95% CI=1.03–1.28), high blood pressure (OR=1.72, 95% CI=1.27–2.34), poor hearing (OR=1.94, 95% CI=1.29–2.92), regular exercise (OR=0.67, 95% CI=0.45–0.99), and normal weight (OR=1.39, 95% CI=1.03–1.86) were significant predictors of cognitive impairment only among women. In contrast, age (OR=1.04, 95% CI=1.01–1.07) and ADL limitations (OR=1.48, 95% CI=1.21–1.82) were significant predictors of cognitive impairment at follow-up only among men.

Conclusion Findings of this study show gender-specific predictors of cognitive impairment among older Koreans. This study can provide information for clinicians and policy makers to develop different intervention strategies considering gender differences in the progress of cognitive impairment.

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Key Words Cognition, Risk factors, Sex differences, Longitudinal studies, Elderly.

INTRODUCTION

With a rapid growth in the older population, geriatric health problems become important concerns worldwide. Cognitive impairment is a major geriatric health problem among older adults because cognitive decline increases with age. Although cognitive decline is a normal aging process, many people concern about cognitive impairment because people with mild cognitive impairment have a high risk of eventually progress-

ing to Alzheimer's disease.¹ According to the Korea Ministry of Health and Welfare,² about 0.5 million older Koreans suffered from dementia in 2012, and the number of older Koreans suffering from dementia is expected to increase up to 2.7 million by 2050. Since dementia is a risk factor for mortality³ and involves high health care costs,⁴ it is not surprising that there is a growing interest in cognitive health.

In Korea, cognitive impairment and dementia are more prevalent among women than men.^{5,6} The number of older adults aged 65 and over diagnosed with dementia in 2012 was about 0.16 million for men and 0.38 million for women, respectively.² Since women outlive men, this statistics may not be surprising. However, many studies reported that being a woman is a risk factor for cognitive impairment.⁷ Gender differences in work and family roles may explain mental health disparities by gender.⁸ Since women have lower education, lower wages, and less social benefits than men, disadvantages

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in socioeconomic structure could lead to gender differences in the prevalence of cognitive impairment.

Previous studies have identified several socio-demographic factors, health factors, and health behaviors as predictors of variability in cognition in later life. Among the socio-demographic factors, older age,⁹ not cohabiting with a partner,¹⁰ lower education,¹¹ lower income,⁹ and living in a rural area¹² were associated with poor cognitive functioning. In terms of health factors, having poor self-rated health,¹³ having ADL or IADL limitations,⁹ having chronic illnesses,¹⁴ being sensory impaired,¹⁵ and being depressed¹⁶ were all risk factors for declines in cognitive functioning. Health behaviors have also been taken into account. Current smokers reported poor cognitive functioning,¹⁷ while normal drinkers,¹⁸ people who regularly exercise,¹⁹ people with normal weight,⁹ and people who participate in social activities²⁰ reported good cognitive functioning.

When the magnitude of gender differences regarding above health characteristics determinants were taken into account, structural and psychosocial factors were more important for women, while behavioral factors were more important for men.²¹ Therefore, predictors of cognitive impairment may be different by gender. However, studies identifying gender-specific risk factors for cognitive impairment are rare, and if gender-specific models were examined, most studies were conducted in a cross-sectional design.^{7,22} Since longitudinal studies examining predictors of cognitive impairment are few, it is not clear which gender-specific factors have causal relationships with cognitive impairment. Therefore, this study attempts to fill this gap and examine the gender-specific incidence and predictors of cognitive impairment, using a nationally representative sample of older Koreans from 2006 to 2012.

METHODS

Study sample

Data for this study came from the 2006 and 2012 waves of the Korean Longitudinal Study of Ageing (KLoSA), a nationally representative longitudinal survey including community-dwelling middle and old-aged population who are aged 45 and over. The sampling framework was based on the probability proportional to size (PPS) systematic sampling of the 2005 Korean Census and Housing Enumeration Districts (ED), stratified by 15 metropolitan areas and provinces, urban/rural regions, and apartment building/non-apartment dwelling. Age-eligible households were selected within each ED. Using a multistage stratified probability sampling based on geographical areas, respondents in individual households were interviewed using computer assisted personal interviewing (CAPI) methods. The KLoSA survey includes questionnaires on demographics, family, health, employment, income,

assets, and subjective expectations and satisfaction.²³ The first KLoSA survey was conducted in 2006, with 10,254 respondents among 6,171 households. In 2008, 8,688 respondents were followed-up. In the 2010 third wave, 7,920 respondents were followed-up. The fourth wave in 2012 comprised 7,486 respondents, representing 73.0% of the original panel.

In this study, the sample was restricted to older adults aged 65 and over at baseline who completed both 2006 and 2012 interviews, and were not cognitively impaired at baseline. Cognitive impairment was defined based on the cut-off scores (2 standard deviation of the mean) from the K-MMSE normative data (see also Measures section). Among 7,486 respondents who completed both 2006 and 2012 interviews, 4,686 respondents under age 65 were excluded. Among 2,800 respondents who met the age criteria, 805 respondents who were cognitively impaired at baseline were excluded from the sample. Among 1,995 respondents who met sample criteria, a pool of 1,759 subjects remained eligible for empirical analysis after listwise deletion of cases with missing values. The sample was subdivided into female and male groups, which consisted of 925 and 834 subjects, respectively.

Measures

Cognitive impairment

The measure of cognitive impairment was assessed with the Korean version of the Mini-Mental State Examination (K-MMSE) that had a maximum score of 30 points.²⁴ Both validity and reliability of K-MMSE instrument were established (Cronbach's alpha: 0.880).²⁴ K-MMSE is widely used for screening of cognitive impairment among older adults,²⁴ and the normative data for K-MMSE has been developed for clinical use.²⁵ Based on age, gender, and educational strata, the cut-off scores (2 standard deviation of the mean) from the K-MMSE normative data were used to determine cognitive impairment.²⁵ In this study, cognitive impairment measured at baseline was used for sample criteria, and cognitive impairment measured at follow-up was used as a dependent variable. Cognitive function (K-MMSE score) at baseline was also used as a covariate to predict cognitive impairment at follow-up.

Socio-demographic factors

In this study, age (in years), marital status (1=married, 0=others), a set of dichotomous variables of education (less than middle school (reference group), middle school graduate, high school graduate, and some college or more), household income (in quartiles), and region (1=living in a major city, 0=others) were included as pre-existing socio-demographic factors. Household income was measured from the

imputed dataset.²⁶ All socio-demographic factors were measured at baseline.

Health factors

Self-rated health was assessed with a 5-point likert scale, then dichotomized (1=fair/poor health, 0=good/very good/excellent health). Functional difficulty was measured with the number of Activities of Daily Living (ADL) and Instrumental Activities of Daily Living (IADL) limitations.²⁷ ADL items included having difficulty in dressing, washing face and hands, bathing, eating, transfer, toileting, and continence.²⁸ IADL items included having difficulty in decorating, housework, preparing meals, laundry, outgoing for a short distance, using transportation, shopping, handling money, using telephone, and taking medicine.²⁹ Each ADL and IADL item was dichotomized (1=need any help, 0=otherwise), then the sum scores of ADLs and IADLs were constructed. ADLs ranged from 0 to 7, and IADLs ranged from 0 to 10. Both validity and reliability of ADL and IADL instruments were established (Cronbach's alpha: 0.949 for ADL and 0.938 for IADL).^{28,29} Several physician-diagnosed chronic conditions (high blood pressure, diabetes, lung disease, liver disease, heart disease, and cerebrovascular disease) were measured, and each chronic condition was dichotomized (1=ever been diagnosed by a doctor, 0=otherwise). Based on the self-reported status of eyesight and hearing, poor eyesight was dichotomized (1=having fair/poor eyesight, 0=otherwise). Similarly, poor hearing was dichotomized (1=having fair/poor hearing, 0=otherwise). Depression was measured by using Korean version of the short-form (10-item) Center for Epidemiological Studies Depression (CES-D) scale.^{30,31} Both validity and reliability of CES-D instrument were established³⁰ (Cronbach's alpha: 0.796). The respondents were asked whether they had depressive symptoms during the past week. Each item was coded as 1 if the respondent had depressive symptoms more than three days. Two positive items were coded reversely. Respondents with more than 4 depressive symptoms were considered as being depressed.^{31,32} All health factors were measured at baseline.

Health behaviors

Smoking status was dichotomized (1=current smoking, 0=otherwise). Drinking status was dichotomized based on the respondents' drinking behavior (1=normal drinking, 0=otherwise).¹⁸ In the KLoSA, the CAGE questions (cutting down, annoyance by criticism, guilty feeling, and eye-openers) were used to identify the respondent's drinking behavior. If the current drinker answered "yes" to one or none of the four CAGE questions, the respondent was considered to have normal drinking behavior.³³ Physical activity was dichotomized (1=

regular exercise, 0=otherwise). Body mass index (BMI) was dichotomized (1=normal weight, 0=otherwise) based on the definition from World Health Organization.³⁴ Number of social participation ranged from 0 to 7, including attending religious meeting, social clubs, leisure group, alumni society, volunteer groups, political party, and others. All health behaviors were measured at baseline.

Statistical analysis

In this study, analyses were conducted separately for females and males. For the descriptive analyses, means (M) and standard deviation (SD) were used to assess the sample characteristics. t-tests and chi-square tests were conducted to evaluate the gender differences in descriptive statistics. Then the generalized estimating equations model (GEE) was used to investigate predictors of cognitive impairment, accounting for autocorrelation issue. Due to the complexity of sampling design, all statistical analyses were conducted based on the weighted data using SPSS version 19 (IBM SPSS Inc., Chicago, IL, USA).

RESULTS

Descriptive statistics

Table 1 contains descriptive statistics for the study sample. The incidence of cognitive impairment at 2012 was higher among women than men (female: 30.5%, male: 26.1%; $p=0.010$). In comparison, 35.0% of women and 20.0% of men were cognitively impaired at baseline. About 53.5% of women were married, while 92.5% of men were married. Compared to women, men were more educated, had higher household income, had better self-rated health, had less high blood pressure, had more lung disease, had less poor eyesight, were less depressed, and were more engaged in health behaviors.

Generalized estimating equations result

Table 2 contains the empirical result of a generalized estimating equations (GEE) model that describes predictors of cognitive impairment at follow-up. For both gender groups, depression was a significant predictor of cognitive impairment at follow-up controlling for other covariates (female: OR=2.26, $p<0.001$; male: OR=3.26, $p<0.001$). Among women, having IADL limitations (OR=1.15, $p=0.015$), high blood pressure (OR=1.72, $p<0.001$), poor hearing (OR=1.94, $p=0.001$), regular exercise (OR=0.67, $p=0.042$), and normal weight (OR=1.39, $p=0.030$) were significantly associated with cognitive impairment at follow-up. In contrast, age (OR=1.04, $p=0.023$) and ADL limitations (OR=1.48, $p<0.001$) were significant predictors of cognitive impairment at follow-up only among men.

DISCUSSION

This study was designed to examine the gender-specific incidence and predictors of cognitive impairment among older adults in Korea. Women had significantly higher incidence of cognitive impairment than men. Corresponding to previous studies, depression was a strong predictor for cognitive impairment in both female and male groups.¹⁶ However, several risk factors had different impacts on cognitive impairment

by gender. Among women, IADL limitations, high blood pressure, poor hearing, regular exercise, and normal weight were significantly associated with cognitive impairment. In contrast, age and ADL limitations were significantly associated with cognitive impairment only among men.

In this study, several factors were unique predictors of cognitive impairment only among women. First, more IADL limitation was significantly associated with cognitive impairment. Since some of the IADL functions (housework, shop-

Table 1. Sample Characteristics at Baseline (2006)

	Total (N=1,759)		Female (N=925)		Male (N=834)		p-value
	Mean (%)	SD	Mean (%)	SD	Mean (%)	SD	
Dependent variable							
Cognitively impaired at 2012*	28.5		30.5		26.1		0.010
Socio-demographic factors							
Age (65–91)	71.1	4.89	71.2	4.99	71.0	4.77	0.496
Married	71.4		53.5		92.5		<0.001
Educational attainment							<0.001
Less than middle school	67.2		83.7		47.7		
Middle school graduate	10.5		7.3		14.2		
High school graduate	15.2		7.4		24.5		
Some college or more	7.1		1.6		13.6		
Household income† (median)	864.0		719.0		1087.0		<0.001
Living in a major city	37.4		36.0		39.0		0.700
Health factors							
Fair/poor health	39.0		49.2		27.0		<0.001
Number of ADL	0.1	0.40	0.1	0.38	0.1	0.43	0.324
Number of IADL	0.4	1.19	0.4	1.20	0.4	1.17	0.576
High blood pressure	39.6		42.8		35.8		0.002
Diabetes	14.4		15.5		13.1		0.162
Lung disease	3.1		1.8		4.7		0.001
Liver disease	1.5		0.9		2.3		0.019
Heart disease	7.8		7.9		7.6		0.701
Cerebrovascular disease	3.2		2.5		4.0		0.061
Poor eyesight	31.3		34.8		27.0		<0.001
Poor hearing	10.8		9.2		12.7		0.012
Depression	37.7		45.0		29.1		<0.001
Cognition score at 2006‡	25.3	3.11	24.3	3.42	26.5	2.16	<0.001
Health behaviors							
Current smoking	15.3		3.7		29.0		<0.001
Normal drinking	25.2		10.8		42.1		<0.001
Regular exercise	36.8		31.0		43.7		<0.001
Normal weight	43.8		41.3		46.7		0.035
Number of social participation	0.9	0.85	0.8	0.76	1.1	0.93	<0.001

*cognition score at 2012 (mean: 21.8, SD: 7.46 for total/mean: 21.0, SD: 7.20 for female/mean: 22.7, SD: 7.65 for male), †annual household income in 10,000 Korean won, ‡cognitively impaired at 2006 (28.8% for total/35.0% for female/20.0% for male). SD: standard deviation

ping, and meal preparation) can be routine work for women, limitation on these functions may be more problematic for women. Therefore, the impact of IADL limitation on cognitive impairment may be apparent among women. Second, high blood pressure was found to be a risk factor for cognitive impairment among older women in Korea. Previous studies of-

ten reported that high blood pressure is a risk factor for cognitive impairment.³⁵ Moreover, studies showed that blood pressure levels increase in women after menopause.³⁶ In other words, loss of estrogen with menopause may be related to the elevated blood pressure level among postmenopausal women. Differences in hemodynamic characteristics and hormonal pro-

Table 2. Generalized estimating equations result: predictors of cognitive impairment at follow-up

	Total (N=1,759)	Female (N=925)	Male (N=834)
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Socio-demographic factors			
Female	1.00 (0.73, 1.36)		
Age	1.03 (1.01, 1.06)**	1.03 (1.00, 1.06)	1.04 (1.01, 1.07)*
Married	1.02 (0.75, 1.38)	1.13 (0.81, 1.58)	0.76 (0.44, 1.32)
Education (ref: less than middle school)			
Middle school graduate	0.79 (0.50, 1.25)	0.92 (0.50, 1.69)	0.65 (0.35, 1.20)
High school graduate	0.97 (0.65, 1.44)	1.07 (0.54, 2.12)	1.00 (0.63, 1.58)
Some college or more	0.99 (0.58, 1.70)	0.88 (0.21, 3.65)	0.99 (0.52, 1.89)
Household income (ref: 1st quartile)			
2nd quartile	0.83 (0.62, 1.11)	0.85 (0.59, 1.23)	0.84 (0.54, 1.29)
3rd quartile	0.98 (0.69, 1.39)	1.16 (0.75, 1.80)	0.92 (0.56, 1.51)
4th quartile	0.89 (0.62, 1.28)	0.93 (0.60, 1.45)	1.00 (0.58, 1.73)
Living in a major city	0.92 (0.72, 1.18)	0.81 (0.59, 1.10)	1.17 (0.83, 1.66)
Health factors			
Fair/poor health	0.88 (0.67, 1.17)	0.75 (0.54, 1.06)	1.02 (0.66, 1.58)
Number of ADL	1.31 (1.13, 1.51)***	1.18 (0.96, 1.43)	1.48 (1.21, 1.82)***
Number of IADL	1.12 (1.03, 1.21)**	1.15 (1.03, 1.28)*	1.08 (0.97, 1.21)
High blood pressure	1.40 (1.10, 1.79)**	1.72 (1.27, 2.34)***	1.13 (0.79, 1.62)
Diabetes	1.13 (0.84, 1.53)	1.06 (0.73, 1.54)	1.21 (0.77, 1.91)
Lung disease	1.48 (0.89, 2.45)	1.12 (0.40, 3.15)	1.58 (0.89, 2.78)
Liver disease	0.90 (0.36, 2.30)	0.84 (0.08, 8.40)	0.84 (0.26, 2.70)
Heart disease	0.72 (0.46, 1.14)	0.68 (0.39, 1.21)	0.70 (0.36, 1.37)
Cerebrovascular disease	1.27 (0.76, 2.13)	0.93 (0.31, 2.82)	1.38 (0.80, 2.38)
Poor eyesight	1.05 (0.80, 1.38)	0.97 (0.69, 1.36)	1.24 (0.84, 1.83)
Poor hearing	1.36 (0.98, 1.90)	1.94 (1.29, 2.92)**	0.87 (0.54, 1.39)
Depression	2.59 (2.00, 3.36)***	2.26 (1.63, 3.12)***	3.26 (2.19, 4.83)***
Cognition score at 2006	0.99 (0.95, 1.03)	0.99 (0.95, 1.04)	0.95 (0.87, 1.02)
Health behaviors			
Current smoking	0.88 (0.62, 1.25)	0.97 (0.51, 1.84)	0.89 (0.59, 1.35)
Normal drinking	0.88 (0.64, 1.20)	1.08 (0.68, 1.71)	0.84 (0.56, 1.24)
Regular exercise	0.73 (0.55, 0.97)*	0.67 (0.45, 0.99)*	0.95 (0.66, 1.37)
Normal weight	1.36 (1.08, 1.73)*	1.39 (1.03, 1.86)*	1.15 (0.81, 1.63)
Number of social participation	1.01 (0.86, 1.18)	1.06 (0.86, 1.32)	0.90 (0.74, 1.10)
Goodness of fit			
QIC	1864.1	1172.1	889.6

* $p < .05$, ** $p < .01$, *** $p < .001$. QIC: quasi likelihood under independence model criterion, ADL: activity of daily living, OR: odds ratio, CI: confidence interval, Ref: reference group

files could explain why older women with high blood pressure were more likely to be cognitively impaired.³⁶ Third, this study finding suggests that older women with poor hearing were more likely to be cognitively impaired. Since older adults with hearing impairments can have communication problems,³⁷ their social network can become limited. In addition, psychosocial factors such as social ties and social support play more important role on cognitive health among women than among men.²¹ Therefore, poor hearing can be a significant risk factor for cognitive impairment among women. Fourth, regular exercise was found to be a protective factor for cognitive impairment. Women tend to have more vascular risk factors (ex. stress, abdominal obesity, high blood pressure, and high total cholesterol), and the beneficial effect of exercise on both dementia and vascular disease has been well reviewed.³⁸ Therefore, exercise can be effective on cognitive health among women. Fifth, normal weight was found to be a risk factor for cognitive impairment among older women in Korea. Often, Korean women with normal weights have abdominal obesity, which is a serious risk factor for cognitive impairment. Since the effect of BMI on cognition is inconclusive, using different measures such as waist-hip ratio or waist circumference may explain this unexpected finding.

On the contrary, several risk factors for cognitive impairment were found only among men. First, age was a significant risk factor for cognitive impairment only among men. This is unexpected finding because age has been consistently found to be a strong risk factor for cognitive impairment for both genders. Among women in our study sample, age-related health changes between 6 years had significant impact on cognitive impairment. Therefore, the unique effect of age itself may have not been apparent. Second, more ADL limitation was significantly associated with cognitive impairment among men. In Korean culture, older men get more assistance when they have limitations in basic activities, which make them feel helpless. Since negative mood worsens cognitive activities,³⁹ ADL limitations may accelerate cognitive impairment among Korean men.

There are some limitations in this study that should be noted. First, cognitive impairment was defined using a screening tool. Therefore, cognitive impairment prevalence may be higher than those actually diagnosed. Second, as with any secondary data analysis, several biological risk factors (e.g., APOE-e4 genotype, metabolic syndromes, etc.) could not be analyzed in this study. Since biological risk factors highly predict the cognitive impairment and dementia,⁴⁰ clinical studies including these measures are recommended.

Although we had several limitations in our study, this study makes a number of important contributions. First, this study investigated the relationship between risk factors and cogni-

tive impairment among Korean older adults using a nationally representative sample. Therefore, the findings from this study can be generalized. Second, this study examined gender differences, which could establish gender-specific strategies for the prevention and treatment of cognitive impairment among older adults in Korea. Third, this is a longitudinal study evaluating predictors of cognitive impairment in a 6-year period. Therefore, the results of this study can suggest causal relationships.

To conclude, this study holds significance as it investigated the gender-specific incidence and predictors of cognitive impairment among older Koreans using nationally representative sample. Development of cognitive impairment was greater in older women, and gender specific risk factors for cognitive impairment were observed among older Koreans. This study suggests that clinicians and policy makers may need to consider gender in the progression of cognitive impairment. Further study is needed to examine the detailed causal relations between each gender specific risk factor and cognitive impairment.

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