Fall experience and cognitive function in middle aged and elderly population

Jae-Hyun Kim\textsuperscript{a,b,}\ast

Abstract

This study estimates the association between the fall experience in the last 2 years and cognitive function and further evaluate the differences in this association between men and women and across different age groups. Data from the Korean Longitudinal Study of Ageing from 2006 to 2016 was used and 9279 research samples were included at baseline in 2006. To analyze the association between fall experience for the last 2 years and cognitive function, generalized estimating equation model and chi-square test were used. After adjusting for all confounders, those with fall experience were significantly associated with cognitive decline. With non-fall experience as reference: fall experience, \( B = -0.013 \) (\( P = .017 \)). In the 64 years or less group, fall experience was significantly associated with cognitive decline (\( P \)-value: 0.006) to those with non-fall experience. In male group, with non-fall experience as reference: fall experience, \( B = -0.017 \) (\( P = .041 \)). Fall experience in the last 2 years is associated with cognitive decline, especially in those 64 years or less and male group. Therefore, self-reported screening for fall experience might aid population-based prevention strategies for cognitive decline, especially in 64 years or less and male.

Abbreviations: CES-D = Center for Epidemiologic Studies Depression, CI = confidence interval, GEE = generalized estimating equation, KLoSA = Korean Longitudinal Study of Ageing, K-MMSE = Korean Mini-Mental State Examination, SD = standard deviation.

Keywords: economic activity, elderly, health, restriction

1. Introduction

Due to the increasing longevity in the lifespan of our population, a noticeable increase in multimorbidity is of much concern, with falls being a source of both morbidity and mortality. In the community-dwelling aged population, about a third experience at least one fall each year.\cite{1,2} Furthermore, these falls could lead to problems such as cognitive impairment and possibly increase the risk of institutionalization or mortality.\cite{3}

In most cases, the occurrence of falling is caused by more than one problem.\cite{4} This is supported by findings of previous studies that show associations between multiple risk factors (e.g., weakness in muscle, gait and balance, cognitive impairment, previous history of falls, arthritis, depression, poor visual acuity, chronic diseases, postural hypotension, or psychotropic medication) and increased risk of falls.\cite{1,2,4-6} Also, the presence of these risk factors have shown association with adverse physical consequences (e.g., fracture, restriction of activity), deterioration of health, increased social isolation as well as increased risk of institutionalization.\cite{7,8} Subsequently, various adverse outcomes such as disability, quality of life and mortality and effects.\cite{9,10}

Even though it was evident that falls, depression and cognitive impairment share common risk factors,\cite{11,12} it is yet unclear which risk factors need more attention in regards to community interventions.\cite{13} Furthermore, although a number of studies have indicated physical and functional outcomes of falls (e.g., fractures, soft-tissue injury, premature institutionalization, and deaths), the same cannot be said in regards to long-term emotional and cognitive outcomes.\cite{11,14} In this regard, understanding the fall-cognition pathway is a crucial aspect in order to design interventions targeted to address potential pathways to cognition as well as falls. Additionally, it is important to understand how fall experience affects cognitive function, because such understanding would further assist in terms of designing interventions for physical disability as well as fall-related mental health. These relationships still seem unexplored for Korean middle-aged and elderly population. In particular, the effects of fall experiences by gender (male and female) and age (elderly group and non-elderly group) on cognitive decline are less known, so our study performed stratification analysis on gender and age group.

The objectives of our study was to examine the association between experience of falls and subsequent change in cognitive function over a 10-year follow-up in a community sample of middle aged and elderly population. Furthermore, the differences between male and female elderly population were evaluated.

2. Methods

2.1. Data source

The data used for the following analyses were derived from the Korean Longitudinal Study of Ageing (KLoSA) from 2006 to 2016. KLoSA was constructed by repeatedly surveying the
identical content for the same respondents every year and repeatedly measured from the 2006 (1st wave) to 2016 (6th wave) to collect observation cases at multiple points in time. This survey involves multistage stratified randomly probability sampling to create a nationally representative sample of community-dwelling Koreans 45 years of age and older based on geographical areas and housing types across Korea.

In the first baseline survey (2006), 10,254 individuals in 6171 households were interviewed. The second survey, in 2008, followed up with 8675 subjects, who represented 86.6% of the original panel. The third survey, in 2010, followed up with 8229 subjects, who represented 81.7% of the original panel, the fourth survey, in 2012, followed up with 7813 subjects, who represented 80.1% of the original panel and the fifth survey, in 2014, followed up with 8387 subjects (including 920 new participated sample), who represented 80.4% of the original panel. The sixth survey, in 2016, followed up with 9913 subjects (including 878 new participated sample), who represented 79.6% of the original panel.

We excluded individuals for whom we had incomplete data: 33 individuals who lacked information on socioeconomic factors and one individual who lacked information on health status and risk factors, 74 individuals who lacked information on CESD, 791 individuals who lacked information on grip strength, and 76 individuals who lacked information on MMSE in 2006. Finally, 9279 research samples were included. This study does not need ethical approval because it is not a study using human derivatives, and all subjects are encrypted and cannot be identified.

2.2. Independent variables

Fall experience in the last 2 years was assessed by self-reported response to the question: “Have you ever had a fall experience since the last survey?” the responses were assigned to “Yes” or “No.”

2.3. Dependent variables

The study considered a two-fold dependent variable, which was measured by using the Korean Mini-Mental State Examination (K-MMSE) as cognitive impairment and grip strength. The K-MMSE included 11 items in seven categories of cognitive functions, including orientation for time and place, registration, attention & calculation, recall, language, and visual construction.[15,16] The total score of the measure ranges from 0 to 30; higher the score, better the cognitive function. The validity of the K-MMSE was reported elsewhere.[13]

2.4. Control variables

2.4.1. Socioeconomic and demographic factors. Age groups were divided into three categories: 45 to 54, 55 to 64 and ≥65 years of age. Education level was categorized into four groups: elementary school or lower, middle school, high school, and college or higher. Gender was categorized as male and female. Residential regions were categorized as Metropolitan (Seoul), urban (Daejeon, Daegu, Busan, Incheon, Kwangju, or Ulsan) or rural (not classified as a city). Marital status was divided into three groups: married, separated or divorced, and single. Health insurance was categorized into national health insurance and medical aid.

2.4.2. Health status and behavioral factors. Grip strength was measured by a handgrip dynamometer (Model number: NO6103, TANITA, Japan). The test was performed in a sitting position with the elbow flexed at 90° on both the right and left sides. The mean strength was calculated from grip strength on both sides.[17] Grip strength in each year was divided into three groups: low, middle, and high using SAS Rank function. Economic activity and regular exercise more than once a week was categorized into Yes and No. Smoking status was categorized into three groups: current smoker, former smoker, and never smoker. Alcohol use also was divided into three groups: current drinker, former drinker, and never drinker. Self-rated health was categorized into three groups: very good, good, normal, bad, and worst. Finally, the number of chronic diseases (consisting of hypertension, diabetes, osteoarthritis, rheumatoid arthritis, cancer, chronic pulmonary disease, liver disease, cardiovascular disease, and cerebrovascular disease) and year dummies were included as covariates in our analyses.

2.4.3. Analytical approach and statistics. Chi-square test and a generalized estimating equation (GEE) model were used to investigate the association between fall experience in the last 2 years and cognitive function. The use of a GEE model was required in order to handle the unbalanced data with correlated outcomes over time. To determine whether cognitive function changed over time, we included time (year) in the model as a continuous covariate; the regression coefficient was used to estimate both the change in cognitive function and independent variables, annually.[18] For all analyses, statistical significance was set to P ≤ .05, two-tailed. All analyses were conducted using the SAS statistical software package, version 9.4 (SAS Institute Inc., Cary, NC).

3. Results

3.1. Prevalence of cognitive function

Table 1 displays the descriptive statistics of all variables at baseline (2006). Of the 9279 research subjects included in our study, mean of cognitive function (MMSE) 2.84 points standard deviation (SD: 2.60). Of the total sample population, mean of cognitive function in those with fall experience in the last 2 years had 23.3 points (SD: 5.7).

3.2. Association between fall experience in the last 2 years and cognitive function

Table 2 shows the relationship between fall experience in the last 2 years and cognitive function adjusted for socioeconomic status and health risk and status behavior factors. After adjusting for all of these confounders, estimate of cognitive function in those with fall experience was −0.013 lower (95% confidence interval [CI]: −0.023 to −0.002) (P-value: .017) compared with those without fall experience.

3.3. Association between fall experience in the last 2 years and cognitive function by age and gender

Table 3 shows subgroup analysis according to age (64 years or less and 65 years or more) and gender (male and female). In 64 years or less, estimate of cognitive function in those with fall experience was −0.016 lower (95%
CI: −0.027 to −0.005 P-value: .006) and in male, estimate of those with fall experience was −0.017 (95% CI: −0.033 to −0.001 P-value: .041) compared with those with non-fall experience.

4. Discussion

In this population-based prospective study of 9279 middle aged and older adults at baseline, our primary purpose was to investigate whether fall experience in the last 2 years was
Table 2
Adjusted effect between fall experience and mental health.

|                          | Model 1                  | Model 2                  |
|--------------------------|--------------------------|--------------------------|
|                          | B  | 95% CI    | P-value | B  | 95% CI    | P-value |
| Fall experience for the last 2 years |                |                        |     |                |                        |
| Yes                      | -0.013 | -0.023 | -0.002 | 0.017 | -0.010 | -0.020 | 0.000 | 0.054 |
| No                       | Ref                   |                        |     | Ref                   |                        |
| CESD                     | -0.009 | -0.009 | -0.008 | <0.001 | -0.075 | -0.080 | -0.069 | <0.001 |
| Education level          |                |                        |     |                |                        |
| < Elementary school      | -0.078 | -0.083 | -0.072 | <0.001 | -0.075 | -0.080 | -0.069 | <0.001 |
| Middle school            | -0.016 | -0.021 | -0.010 | <0.001 | -0.014 | -0.019 | -0.008 | <0.001 |
| High school              | -0.010 | -0.015 | -0.005 | <0.001 | -0.009 | -0.014 | -0.004 | 0.000 |
| ≥ College                | Ref                   |                        |     | Ref                   |                        |
| Gender                   |                |                        |     |                |                        |
| Male                     | -0.018 | -0.023 | -0.013 | <0.001 | -0.015 | -0.020 | -0.010 | <0.001 |
| Female                   | Ref                   |                        |     | Ref                   |                        |
| Age                      |                |                        |     |                |                        |
| <54                      | Ref                   |                        |     | Ref                   |                        |
| 55–64                    | -0.019 | -0.026 | -0.012 | <0.001 | -0.016 | -0.023 | -0.014 | <0.001 |
| ≥65                      | -0.022 | -0.031 | -0.019 | <0.001 | -0.033 | -0.037 | -0.029 | <0.001 |
| Marital status           |                |                        |     |                |                        |
| Married                  | -0.008 | -0.017 | 0.016  | 0.956 | -0.011 | -0.024 | 0.009  | 0.359 |
| Separated, divorced      | -0.048 | -0.065 | -0.031 | <0.001 | -0.050 | -0.066 | -0.033 | <0.001 |
| Single                   | Ref                   |                        |     | Ref                   |                        |
| Residential region       |                |                        |     |                |                        |
| Metropolitan             | Ref                   |                        |     | Ref                   |                        |
| Urban                    | -0.019 | -0.026 | -0.012 | <0.001 | -0.012 | -0.019 | -0.004 | 0.002 |
| Rural                    | -0.017 | -0.022 | -0.013 | <0.001 | -0.016 | -0.023 | -0.014 | <0.001 |
| Health insurance         |                |                        |     |                |                        |
| National Health Insurance| Ref                   |                        |     | Ref                   |                        |
| Medical aid              | -0.019 | -0.026 | -0.012 | <0.001 | -0.012 | -0.019 | -0.004 | 0.002 |
| Self-rated health        |                |                        |     |                |                        |
| Good                     | Ref                   |                        |     | Ref                   |                        |
| Normal                   | -0.009 | -0.012 | -0.005 | <0.001 | -0.005 | -0.008 | -0.001 | 0.006 |
| Bad                      | -0.057 | -0.062 | -0.052 | <0.001 | -0.057 | -0.062 | -0.052 | <0.001 |
| Grip strength            |                |                        |     |                |                        |
| Q1                       | -0.073 | -0.079 | -0.068 | <0.001 | -0.067 | -0.072 | -0.062 | <0.001 |
| Q2                       | -0.013 | -0.018 | -0.009 | <0.001 | -0.010 | -0.014 | -0.006 | <0.001 |
| Q3                       | Ref                   |                        |     | Ref                   |                        |
| Number of chronic disease*|                |                        |     |                |                        |
| 0                        | Ref                   |                        |     | Ref                   |                        |
| 1                        | -0.030 | -0.033 | -0.027 | <0.001 | -0.020 | -0.023 | -0.016 | <0.001 |
| Smoking status           |                |                        |     |                |                        |
| Never                    | -0.005 | -0.010 | -0.001 | 0.027 | -0.005 | -0.010 | -0.001 | 0.018 |
| Former smoker            | -0.005 | -0.010 | 0.000  | 0.064 | -0.005 | -0.011 | -0.001 | 0.018 |
| Smoker                   | Ref                   |                        |     | Ref                   |                        |
| Alcohol use              |                |                        |     |                |                        |
| Drinker                  | -0.002 | -0.010 | 0.006  | 0.632 | -0.001 | -0.009 | 0.007  | 0.767 |
| Former drinker           | 0.002  | -0.003 | 0.007  | 0.369 | 0.000  | -0.003 | 0.006  | 0.508 |
| Never                    | Ref                   |                        |     | Ref                   |                        |
| Economic activity        |                |                        |     |                |                        |
| Yes                      | Ref                   |                        |     | Ref                   |                        |
| No                       | -0.021 | -0.024 | -0.018 | <0.001 | -0.018 | -0.021 | -0.014 | <0.001 |
| Regular exercise more than once a week |                |                        |     |                |                        |
| Yes                      | 0.028  | 0.025  | 0.031  | <0.001 | 0.028  | 0.026  | 0.023  | 0.029 |
| No                       | Ref                   |                        |     | Ref                   |                        |
| Year                     |                |                        |     |                |                        |
| 2006                     | -0.015 | -0.020 | -0.010 | <0.001 | -0.013 | -0.018 | -0.008 | <0.001 |
| 2008                     | -0.017 | -0.023 | -0.012 | <0.001 | -0.009 | -0.014 | -0.004 | <0.001 |
| 2010                     | -0.070 | -0.076 | -0.065 | <0.001 | -0.063 | -0.068 | -0.058 | <0.001 |
| 2012                     | -0.028 | -0.033 | -0.023 | <0.001 | -0.022 | -0.027 | -0.017 | <0.001 |
| 2014                     | -0.002 | -0.009 | 0.005  | 0.654 | 0.001  | -0.006 | 0.008  | 0.706 |
| 2016                     | Ref                   |                        |     | Ref                   |                        |

CI = confidence interval.
Table 3
Adjusted effect between grip strength and mental health by age and gender.

|                              | MMSE | 95% CI    | P-value |
|------------------------------|------|-----------|---------|
| Fall experience for the last 2 years |      |           |         |
| Yes 65 years                  | B    | 0.015     | 0.026   | 0.003   | 0.010 |
| No                            | Ref  |           |         |         |
| Fall experience for the last 2 years |      |           |         |
| Yes ≥65 years                 | B    | 0.001     | 0.017   | 0.015   | 0.305 |
| No                            | Ref  |           |         |         |
| Fall experience for the last 2 years |      |           |         |
| Yes Male                      | B    | 0.015     | 0.031   | 0.001   | 0.067 |
| No                            | Ref  |           |         |         |
| Fall experience for the last 2 years |      |           |         |
| Yes Female                    | B    | 0.003     | 0.016   | 0.011   | 0.712 |
| No                            | Ref  |           |         |         |

CI = confidence interval, MMSE = Mini-Mental State Examination.

* Adjusted for several basic characteristics, socio-economic status, health risk, & behavioral factors.

There are several limitations to this study that should be taken into consideration. First, although our study was based on a longitudinal design, it may not fully acknowledge the causality between the variables of interest and cannot be ascertained. Therefore, prospective studies targeting this issue are required to further investigate the causal relationship between fall experience and cognitive function. Second, because the fall history was assessed by interview, there could be a possible recall bias. A prospective study incorporating a daily record of fall experience is needed to overcome the possible recall bias. Third, although our research is based on a large sample size (N=9279), which strengthens the precision in the odds ratio estimation, the fact that individuals with missing values on the critical information were not included need to be taken into consideration. The excluded individuals could have changed our results to overestimate the association between fall experience and cognitive function. Finally, information regarding health status and risky health behaviors was not sufficient. Furthermore, there might have been unobserved confounders. However, the lack of such information might have resulted in an underestimation of our results in the present study. Nevertheless, despite the underestimation, we found a significant association between fall experience in the last 2 years and cognitive function.

Despite these limitations, this study has various strengths, particularly with its use of a population-based representative sample and the 10-year follow-up database. We also prospectively analyzed a large number of individuals from longitudinal data of a well-defined and comprehensively studied sample of middle aged and older adults to examine the association between fall experience in the last 2 years and cognitive function. Therefore, with the rapidly aging population in Korea, fall experience in the last 2 years may be a reasonably good predictor of cognitive function in middle aged and elderly population.

In conclusion, having fall history in the last 2 years was independently associated with cognitive decline over 10 years compared to having no history of falls, with a mediating effect of depression on the association between falls and cognitive decline, especially in those 64 years or less. The findings suggest that screening for cognitive decline problems in those with fall history might help stem the onset of falls-related physical and cognitive disability.

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