



Sex Differences in Fear of Falling among Older Adults with Low Grip Strength

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Abstract

Background: Fear of falling is not only a risk factor for falls, but it is also an important clinical predictor of functional decline in older adults. This study identified sex differences in fear of falling and related factors in older adults with low grip strength.

Methods: The data of 902 older adults from the 2012 Korean National Survey, conducted as a research project by the Korea Employment Information Service, were analyzed. Grip strength, activities of daily living, cognitive function, depressive symptoms, and fear of falling were assessed. Multiple regression analysis was performed by a simultaneous data entry method.

Results: Fear of falling was greater in older women with low grip strength than in their male equivalents ($P<0.001$). Regression analysis showed that age, fall experience within the previous 2 yr, activities of daily living, and depressive symptoms collectively accounted for 15.3% ($P<0.001$) of the variance among men. Meanwhile, age, fall experience within the previous 2 yr, grip strength, activities of daily living, and depressive symptoms collectively accounted for 13.4% ($P<0.001$) of the variance among women.

Conclusion: Thus, the predictors of fear of falling differ between older men and women with low grip strength. Therefore, sex differences must be considered when developing intervention strategies for reducing fear of falling in this demographic.

Keywords: Falls, Fear, Muscle weakness, Sex

Introduction

Grip strength, a health fitness factor of physical activity, is important in the daily life of older adults (1). Grip strength decreases 3% and 5% annually in older men and women, respectively (2). According to investigations by the Foundation for the National Institutes of Health (FNIH) Sarcopenia Project, the prevalence of low grip strength was lower among older (5%) men than among older women (18%) (3). Decreased muscle mass and the subsequent substitution with fat is one reason for this decline. The breakdown in muscle further accelerates the increase in muscle fat content, consequently decreasing muscle strength (4). Such physiological changes lead to psychological impairments, such as

fear of falling and consequently limiting activities of daily living and increasing the risk of falling (5).

Older men and women with low grip strength have 7.62- and 4.42- fold higher risks of impaired physical mobility, respectively, than their respective normal equivalents (3). Compared to their normal equivalents, older people with low grip strength have greater fear of falling and more depressive symptoms (1), as well as lower levels of physical and mental health (6, 7). Among the oldest old, lower handgrip strength was correlated with poorer scores in cognitive function, activities of daily living, depressive symptoms, and loneliness (8). Additionally, low grip strength is reportedly associated with a

greater likelihood of premature mortality, disability development, and increased risk of complications or prolonged length of stay after hospitalization or surgery (9, 10). Several variables, including most domains of age-related disability in women aged ≥ 70 yr such as cognitive impairment, depressive symptoms, and balance and mobility problems, are predictors of a persistent fear of falling (11).

However, very few studies exist concerning fear of falling in older adults with low grip strength, which necessitates improvement interventions. Physiological vulnerabilities differ between the sexes, because men and women are exposed to different types of risks throughout their lives. Furthermore, the influence of social factors may not be the same for both sexes. Therefore, WHO (12) suggests analyzing data separately according to sex. As a high level of fear of falling actually increases the risk of a fall (13), information on factors and events preceding a fall, including assessments of fear of falling, is essential for developing strategies to prevent falls, as well as to define high-risk situations and behaviors.

The present study analyzed the differences in levels of fear of falling and related factors between older men and women with low grip strength to identify the predictors of fear of falling and ultimately provide a foundation for developing customized sex-specific nursing interventions for fall prevention.

Materials and Methods

Study procedure and participants

This study's survey design was cross-sectional and descriptive. Data were obtained from the 4th Korean Longitudinal Study of Aging (KLoSA), conducted in 2012 as a research project by the Korea Employment Information Service. The KLoSA stratified 15 special/metropolitan cities into *dong* and *eup-myeon* areas and further stratified them into enumeration districts of houses and apartments. The stratified population enumeration districts were arranged according to administrative code, and an assigned number of districts were selected from each area through systematic sampling. Thereafter, sample households were extracted through

simple random sampling. Interviewers visited the sample households and collected data through computer-assisted personal interviewing.

The population of the KLoSA included 9758 community-dwelling Korean people aged ≥ 45 yr. Of these, 7813 were interviewed successfully (sample retention rate: 80.1%). Of the respondents, 4362 were older adults aged 60–79 yr, and grip strength was assessed in 3615 of them. Among those for whom grip strength data were available, 415 men (24.7% of the 1679 men) and 487 women (25.2% of the 1936 women) were classified into the low-grip-strength group, and their data were included in the final analysis (Fig. 1). The cut-offs of low grip strength for older adults were < 26 kg and < 16 kg in men and women, respectively (3). A total minimum sample size of 166 (women) and 160 (men) was required for a medium effect size, and α of 0.05, and a power of 0.95 using *F*-tests (with 9 and 8 predictors for women and men, respectively). This effect size was derived from the G-power sample size calculation engine 3.0.10 (14).

Instruments

Sociodemographic characteristics

This study surveyed age, income class (the low-income class was defined as those who were recipients of National Basic Livelihood Security support), physician-diagnosed diabetes, and fall experience within the previous 2 yr. The subjects were subsequently divided with respect to underweight status (i.e., body mass index < 18.5 kg/m²) according to the Koreans' Obesity Treatment guidelines of the Korean Society for the Study of Obesity, which are specific for individuals in the Asia-Pacific region.

Grip strength

Grip strength was measured in kilograms using a model 6103 hand dynamometer (Tanita, Tokyo, Japan), with the arm, forearm, and wrist in neutral positions. The grip strengths of the left and right arms were measured twice. The mean values of the measurements of the dominant hand were used for the analysis.

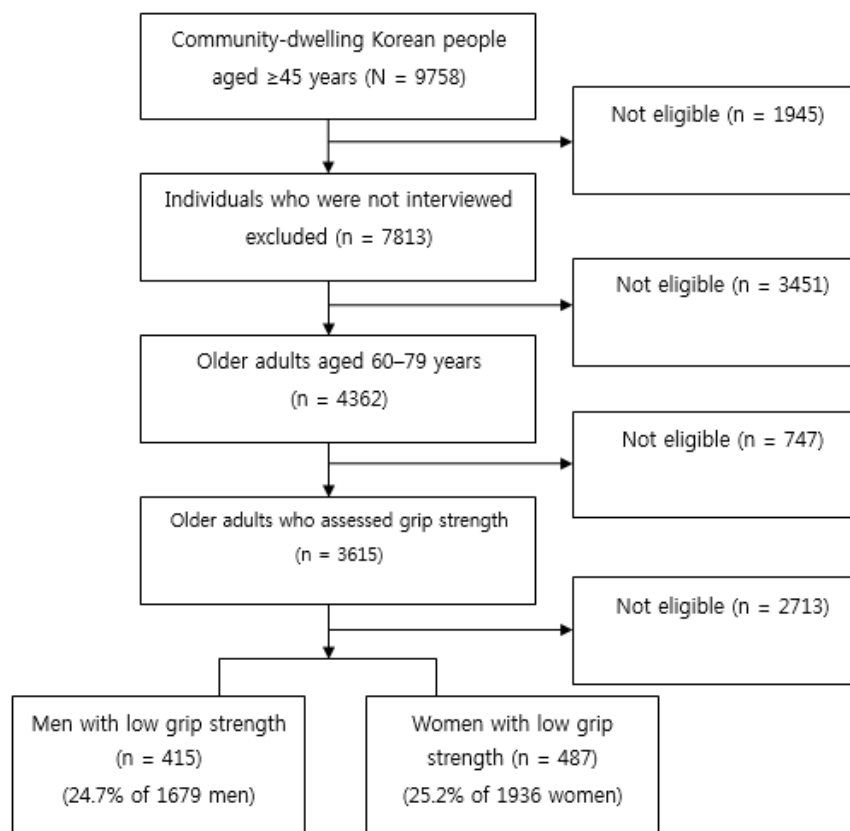


Fig. 1: Flowchart used to choose this study’s participant sample

According to the FNIH Sarcopenia Project, the normal level of grip strength is ≥ 32 kg in men and ≥ 20 kg in women (3).

Activities of daily living

Activities of daily living restrictions were assessed using the Korean version of the Barthel ADL Index (15). The reliability and validity of both the original scale and its subsequent modification have been widely accepted in Korea (16). The instrument consists of 7 questions on grooming, walking, bladder and bowel control, dressing, climbing stairs, feeding, and bathing. Responses of “don’t need help,” “need partial help,” and “need full support” were scored 1, 2, and 3 points, respectively. The total activities of daily living scores ranged from 7–21, with higher scores indicating higher levels of disability in terms of daily living. The Cronbach’s α was 0.97 when the instrument was developed, and it was 0.95 in the present study.

Cognitive function

Cognitive function was measured using the Mini-Mental State Examination (MMSE) (17) and was translated and modified by Kang et al. (18). The Korean version of the MMSE is a standard tool published by Psychological Assessment Resources (19). The instrument assigns 1 point when the instructions for each item are followed correctly and 0 points otherwise. The MMSE comprises 30 items providing information about orientation to time (5 items), orientation to place (5 items), registration (3 items), attention and calculation (5 items), recall (3 items), language (5 items), complex command (3 items), and spatiality (1 item). Total scores ranged from 0–30, and higher scores indicated higher levels of cognitive capability. A score between 24 and 30 indicates no cognitive impairment, while a score between 18 and 23 indicates mild cognitive impairment. The Cronbach’s α for this

measure was 0.85 in the study of Kang et al. (18) and 0.78 in the present study.

Depressive symptoms

Depressive symptoms were measured using the short form of the Center for Epidemiological Studies Depression Scale (CES-D), which simplified Radloff's (20) CES-D into 10 questions for the KLoSA. The criterion validity of the CES-D 10 has been corroborated through factor analysis, and this tool is widely used in Korea (21). The instrument consists of questions concerning the subjects' feelings during the previous week and assigns 0 points for "had such a thought for a moment or not at all," and 1 point for "had such a thought occasionally" or "had such a thought always." The final score was obtained by summing the scores for all responses. The total scores ranged from 0–10, and a score of ≥ 4 was considered to indicate "depressive symptoms" (22). The Cronbach's α was 0.92 in Irwin et al.'s (22) study and 0.85 in the present study.

Fear of falling

Fear of falling was measured with a rating that assigned 1 point for a response of "I don't worry at all" and 3 points for "I worry very much." A higher

score indicated a greater fear of falling. Although it recognized the inherent weakness due to the single-item measures, the form of the question led us to assess a continuous measure, as opposed to a dichotomous measure, for fear of falling (23).

Statistical analysis

Data were analyzed by using SPSS for Windows (version 18.0; SPSS, Chicago, IL, USA). For unbiased calculations of parameter estimators from the data of this panel survey, we used cross-sectional weighting. The χ^2 test was conducted to verify the homogeneity of the participants' sociodemographic characteristics. Differences in grip strength, activities of daily living, cognitive function, depressive symptoms, and fear of falling between men and women were analyzed using an independent-sample *t*-test. Pearson's coefficients were calculated to determine the correlations between these variables and fear of falling. Each variable that significantly correlated with fear of falling was included as an independent variable in multiple linear regression analysis. A simultaneous data entry method was used. The threshold of significance was set at $P < 0.05$.

Table 1: Sociodemographic characteristics ($n = 902$)

Variable	Total ($n = 902$) <i>n</i> (weighted %)	Men ($n = 415$) <i>n</i> (weighted %)	Women ($n = 487$) <i>n</i> (weighted %)	χ^2 (<i>P</i>)
Age (yr)				1.305 (0.253)
60–69	332 (36.8)	161 (38.8)	171 (53.4)	
70–79	570 (63.2)	254 (61.2)	316 (46.6)	
Mean \pm SD	71.0 \pm 5.52	70.9 \pm 5.62	71.1 \pm 5.46	
Low income				1.479 (0.224)
Yes	36 (4.0)	13 (3.1)	23 (4.7)	
No	866 (96.0)	402 (96.9)	464 (95.3)	
Diabetes mellitus				0.998 (0.318)
Yes	20 (2.2)	7 (1.7)	13 (2.7)	
No	882 (97.8)	408 (98.3)	474 (97.3)	
Underweight				0.710 (0.399)
Yes	40 (4.4)	21 (5.1)	19 (3.9)	
No	862 (95.6)	394 (94.9)	468 (96.1)	
Fall in the previous 2 yr				4.866 (0.057)
Yes	19 (1.6)	4 (1.0)	15 (3.1)	
No	883 (98.4)	411 (99.0)	472 (96.9)	

Results

Sociodemographic characteristics

The age (mean \pm SD) of the subjects was 71 ± 5.52 yr; 36.8% ($n=332$) and 63.2% ($n=570$) were in their 60s and 70s, respectively. In addition, 4.0% ($n=36$) were in the low-income class, 2.2% ($n=20$) had diabetes, 4.4% ($n=40$) were underweight, and 1.6% ($n=19$) experienced a fall within the previous 2 yr. There were no significant differences in sociodemographic characteristics between sexes; therefore, the groups were deemed homogeneous (Table 1)

Sex differences for each variable

There were significant differences between the sexes with respect to grip strength ($t=37.925$, $P<0.001$), cognitive function ($t=7.294$, $P<0.001$), depressive symptoms ($t=-5.618$, $P<0.001$), and fear of falling ($t=-11.141$, $P<0.001$) (Table 2). In particular, the level of fear of falling was signifi-

cantly higher in older women with low grip strength than in their male equivalents.

Sex differences in the correlations between fear of falling and the other variables

The correlations between fear of falling and the other variables for older adults with low grip strength according to sex are shown in Table 3. In men, fear of falling was significantly negatively correlated with grip strength ($r=-0.096$, $P=0.040$), and it was significantly positively correlated with activities of daily living ($r=0.180$, $P<0.001$) and depressive symptoms ($r=0.268$, $P<0.001$).

In women, fear of falling was significantly negatively correlated with grip strength ($r=-0.203$, $P<0.001$) and cognitive function ($r=-0.135$, $P=0.003$), and it was significantly positively correlated with activities of daily living ($r=0.141$, $P=0.002$) and depressive symptoms ($r=0.218$, $P<0.001$).

Table 2: Sex differences for each variable ($n = 902$)

Variables	Men (n = 415)	Women (n = 487)	t (P)
	Mean \pm SD	Mean \pm SD	
Grip strength (range: 0–75 kg)	21.25 \pm 3.91	12.82 \pm 2.48	37.925 (<0.001)
Activities of daily living (range: 7–21)	7.13 \pm 1.13	7.12 \pm 0.78	-0.248 (0.804)
Cognitive function (range: 0–30)	24.20 \pm 5.55	21.31 \pm 6.36	7.294 (<0.001)
Depressive symptoms (range: 0–10)	3.59 \pm 2.63	4.63 \pm 2.90	-5.618 (<0.001)
Fear of falling (range: 1–3)	1.72 \pm 0.64	2.18 \pm 0.59	-11.141 (<0.001)

Table 3: Sex differences in the correlations between fear of falling and the other variables by sex ($N = 902$)

Variables	Fear of falling	
	Men (n = 415)	Women (n = 487)
	r (P)	r (P)
Grip strength	-0.096 (0.040)	-0.203 (<0.001)
Activities of daily living	0.180 (<0.001)	0.141 (0.002)
Cognitive function	-0.052 (0.294)	-0.135 (0.003)
Depressive symptoms	0.268 (<0.001)	0.218 (<0.001)

Sex differences in the factors influencing fear of falling

The sex differences in the predictors of fear of falling among older adults with low grip strength are

shown in Table 4. Among the independent variables, low income (Yes=0, No=1), diabetes mellitus (Yes=0, No=1), underweight (Yes=0, No=1), and fall experience within the previous 2 yr (Yes=0,

No=1) were considered dummy variables. In men, age ($\beta=0.162, P=0.001$), fall experience within the previous 2 yr ($\beta=-0.092, P=0.046$), activities of daily living ($\beta=0.152, P=0.001$), and depressive symptoms ($\beta=0.233, P<0.001$) were significant predictors of fear of falling. The explanatory power of this model was 15.3% ($F=8.135, P<0.001$). In

women, age ($\beta=0.152, P=0.001$), fall experience within the previous 2 yr ($\beta=-0.096, P=0.027$), grip strength ($\beta=-0.143, P=0.001$), activities of daily living ($\beta=0.093, P=0.034$), and depressive symptoms ($\beta=0.140, P=0.002$) were significant predictors of fear of falling. The explanatory power of this model was 13.4% ($F=8.089, P<0.001$).

Table 4: Sex differences in the factors influencing fear of falling (N = 902)

Variable	Fear of falling			
		Men (n = 415)		Women (n = 487)
	β	t (P)	β	t (P)
Constant		3.348 (0.001)		4.914 (<0.001)
Age (yr)	0.162	3.445 (0.001)	0.152	3.408 (0.001)
Low income	-0.021	-0.458 (0.647)	-0.073	-1.692 (0.091)
Diabetes mellitus	-0.079	-1.705 (0.089)	-0.072	-1.670 (0.096)
Underweight	-0.083	-1.783 (0.075)	-0.016	-0.365 (0.715)
Fall in the previous 2 yr	-0.092	-2.004 (0.046)	-0.096	-2.218 (0.027)
Grip strength	-0.035	-0.732 (0.465)	-0.143	-3.212 (0.001)
Activities of daily living	0.152	3.250 (0.001)	0.093	2.122 (0.034)
Cognitive function		-	-0.030	-0.658 (0.511)
Depressive symptoms	0.233	4.913 (<0.001)	0.140	3.071 (0.002)
Adjusted R ²		0.153		0.134
F (P)		8.135 (<0.001)		8.089 (<0.001)

Discussion

The gradual decline of muscle strength in older adults is an indicator of body function degradation and is known to restrict physical activities (1). Muscle breakdown induced by insulin resistance, which is crucial in the protein anabolism signal transduction system, decreases muscle mass and strength in older adults (24). The risks of these symptoms can be reduced by decreasing inflammatory cytokine levels through exercise, along with proper nutritional intake. Older men with low grip strength exhibit normal cognitive function, whereas their female equivalents show mild cognitive impairment. The MMSE shows both older men and women have normal cognitive function (≥ 24 points) with no significant differences between them (25).

However, Alencar et al. (26) reported older people with low grip strength have MMSE scores of 17.0–

21.1, and this suggests that further in-depth research is required to clarify the correlation between muscle strength and cognitive function, as well as any sex differences. In the present study, depressive symptoms differed significantly between men and women. This result is similar to a compared depressive symptom levels in community-dwelling frail older men and women with muscle weakness. The presence of mild depressive symptoms in women in the present study suggests the need for interventions to treat depressive symptoms in older women with low grip strength.

Fear of falling was greater in older women with low grip strength than in their male equivalents. Furthermore, the level of fear of falling in women was more than moderate. Concordantly, Choi et al. (6), who compared factors related to the fear of falling between sexes, found the level of fear of falling is higher in women. Similarly, Fletcher and Hirdes (27), who investigated the relationship be-

tween fear of falling and activity restrictions, reported that fear of falling is greater in women. Aged people experience activity restrictions because of pain and discomfort due to musculoskeletal weakening, such as osteoporosis and degenerative arthritis (28). Muscle strength in the lower limbs decreases gradually, and the sense of balance is lost. These conditions exacerbate the psychological anxiety the elderly experience in completing daily activities such as walking. Such symptoms tend to be more severe in women (1). Therefore, women have a higher risk of falling than men.

The variables commonly correlated with fear of falling in older men and women with low grip strength-weak grip strength, and levels of activities of daily living in mobile tasks among older adults-are reported to be strongly negatively correlated with fear of falling (13). Meanwhile, depressive symptoms are positively correlated with fear of falling (6). These findings corroborate the results of the present study. Multiple regression analysis using depressive symptoms as the dependent variable showed that age, fall experience within the previous 2 yr, activities of daily living, and depressive symptoms were significant predictors of fear of falling in both older men and women with low grip strength. Similarly, a study of 9033 Korean adults aged >60 yr reported that age and activities of daily living are significant predictors of fear of falling (29). Another survey of community-dwelling older adults aged >65 yr in China reported that fall experience and depressive symptoms are significant predictors of fear of falling (30).

In the present study, grip strength was a predictor of fear of falling only for older women with low grip strength. Grip strength is a major functional fitness component required for performing activities of daily living safely and independently (31). Older women with low grip strength and physical weakness lose confidence in performing activities of daily living and, consequently, avoid them (7). Furthermore, fear of falling can induce psychological withdrawal, as evidenced by depressive symptoms (32). This aggravates the avoidance of physical activities and further degenerates body functions in a vicious circle.

Among older people who have a fear of falling, physical functions such as static balance and complex mobility are either poor or degenerating (6). Accordingly, older women with low grip strength should be classified and managed as a high-risk group that requires interventions to prevent falls. In another study investigating the relationship between grip strength and fear of falling in older men and women, Kim et al. (1) reported that men in the first grip strength quartile (10.6–25.0 kg) had a fear of falling 10 times greater than that of the men in the fourth quartile. As this finding is inconsistent with the present results, further research into sex differences in the fear of falling in older people is required.

Fear of falling restricts the activities of older people. Accordingly, in the long term, it negatively influences physical functions (13). Falls are particularly problematic for aged persons, because compared to young people older people have more difficulty recovering from physical impairments and functional disorders. In addition, they have more severe impairments complications, including problems that can even lead to death (29). The results of the present study will not only help design-screening instruments to identify older adults at risk of falling but also help develop effective customized intervention strategies for prevention activities based on factors related to the fear of falling.

Despite this study's valuable findings, it has some limitations that need to be addressed. First, the results may not be generalizable to all elderly people, because the subjects were limited to those who met the criterion for low grip strength. Second, as this was a cross-sectional study, the causal relationships among the variables cannot be proven. However, the apparent sex differences in the predictors of fear of falling among older adults with low grip strength indicate that fall prevention programs will need to reflect these differences through tailored assessments and customized interventions.

Conclusion

The older women with low grip strength in the present study showed mild cognitive impairment and mild depressive symptoms. In addition, they

had a stronger fear of falling. Comparisons of the older women and men with low grip strength showed that age, fall experience within the previous 2 yr, activities of daily living, and depressive symptoms were significant predictors of fear of falling. However, grip strength was a significant predictor of fear of falling only for the women.

Considering that fear of falling is an important factor for predicting future falls (13), the present study results show older women with low grip strength are more vulnerable to falls than are their male counterparts. Thus, in order to prevent falls, community healthcare workers should attempt to improve the cognitive functioning, reduce depressive symptoms, and increase the grip strength of older women with low grip strength. Future fall-related research and interventions should be multi-disciplinary and assess physical, psychosocial, cognitive, and rehabilitative aspects, including fear of falling among community-dwelling older adults. Successful interventions developed through such approaches will confer substantial individual and social benefits by aiding the maintenance of the function and independence in activities of daily living of older adults.

Ethical considerations

The author has completely observed and conformed favorably to all ethical issues regarding plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy.

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