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Association of Physical Performance and Pain With Fear of Falling Among Community—Dwelling Japanese Women Aged 65 Years and Older

Yoshihito Tomita, Kazuhiko Arima, MD, PhD, Mitsuo Kanagae, PhD, Takuhiro Okabe, Satoshi Mizukami, PhD, Takayuki Nishimura, PhD, Yasuyo Abe, MD, PhD, Hisashi Goto, MD, PhD, Itsuko Horiguchi, DDS, PhD, and Kiyoshi Aoyagi, MD, PhD

Abstract: Our aim was to explore the association of physical performance and pain with fear of falling among community-dwelling Japanese women.

The subjects were 278 women aged 65 years and over. We collected information on fear of falling, painful joints, comorbidities, falls in the previous year, and cataracts. Walking time (distance of 6 m), chair stand time (5 times), grip strength, the timed up and go test (TUG), and functional reach were measured.

The prevalence of fear of falling was 36.3%, and it increased with age, but it was not significant ($P=0.081$). Multivariate logistic regression analysis showed that poor physical performance (longer walking time, longer chair stand time, weaker grip strength, and longer TUG) and pain (low back, and upper and lower extremity pain) were significantly associated with fear of falling after adjusting for age, body mass index, comorbidities, falls in the previous year, and cataracts.

Maintaining physical functioning and managing pain may be important for elderly women with fear of falling.

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Abbreviations: BMI = body mass index, CI = confidence intervals, OR = Odds ratios, SD = Standard Deviation, TUG = Timed up and go test.

INTRODUCTION

Fear of falling is a major health problem among elderly people living in communities.¹ Fear of falling is associated with reduced levels of physical activity,² reduced ability to perform activities of daily living,^{3,4} increased risk of admission to an aged care institution,⁴ and decreased quality of life.^{5,6} It is common for fear of falling to occur after falls,⁷ but it can also occur without a history of falls.⁸ Previous studies have shown

that fear of falling is affected by several factors such as gender, age, comorbidity, body pain, history of falls, visual impairment, depression, and cognitive function.^{9–11}

Although the relationship between fear of falling and physical performance has been established,^{9,12–16} few studies have focused on elderly residents in Japan.¹⁴ Furthermore, although pain is reported to be associated with fear of falling,^{14,17,18} most studies have investigated general body pain, whereas few have focused on pain in specific areas such as the low back.^{17,19} The objective of the present study was to explore the association of physical performance and pain with fear of falling among community-dwelling Japanese women.

SUBJECTS AND METHODS

This study was performed as a part of the Oshima Health Study, which was an investigation of the health status in community-dwelling residents. Details are described elsewhere.²⁰ The participants of this study were 313 community-dwelling women aged ≥ 65 years, who were non-institutionalized and lived independently in Oshima Town, Nagasaki Prefecture, Japan. The health status investigation was performed in the period from 2001 to 2003 at the Oshima Health Center. All participants had sufficient cognitive functioning to answer the questionnaire.

In order to assess the prevalence of fear of falling, participants were asked whether they feel fear of falling using a question, “Are you afraid of falling?” Self-administered questionnaires were handed, which include the information on painful joints, comorbidities, falls in the previous year, and cataracts. The information on painful joints was collected with a questionnaire: “Which joints are currently painful or have been painful most days for at least the past month?” Participants were answered using a sketch of the skeleton. The answers of painful joints were categorized. For instance, the shoulders, elbows, wrists, and hand/finger joints were categorized into upper extremities; the hips, knees, ankles, and foot joint were categorized into lower extremities. The comorbidity data including heart disease, lung disease, stroke, or diabetes mellitus were collected.

Height (m) and weight (kg) were measured with the subject in light clothing and without shoes, and body mass index (BMI) was calculated as weight/height squared (kg/m^2).

Walking time was quantified as the time of walking a 6-m distance with the subject’s usual walking speed. Chair stand time was quantified as the time of standing up from a standard chair and sitting down in 5 times, without the assistance of their arms. These measured times were calculated into the average of two results. Grip strength was measured using a hydraulic hand dynamometer (Jamar hydraulic hand dynamometer; Jafayette

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From the Department of Public Health, Nagasaki University Graduate School of Biomedical Sciences, Nagasaki, Japan (YT, KA, MK, TO, TN, YA, KA); Department of Rehabilitation, Nishi-Isahaya Hospital, Isahaya, Japan (YT, MK, TO, SM); Goto Health Care Office, Nagasaki, Japan (HG); and Center for Public Relations Strategy, Nagasaki University, Nagasaki, Japan (IH).

Correspondence: Kazuhiko Arima, Department of Public Health, Nagasaki University Graduate School of Biomedical Sciences, 1-12-4 Sakamoto, Nagasaki 852-8523, Japan (e-mail: kzarima-ngs@umin.ac.jp).

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Instrument Company, Inc., Jafayette, IN). The better performance from two trials used their dominant hand was deemed as the result. Timed up and go test (TUG) involves standing from a chair, walking 3 m, turning around, walking back to the chair, and sitting down. Subjects were instructed to complete the task at their usual walking speed. The TUG was quantified as the time of the full task, calculated as the average of 2 results. The functional reach test was quantified as the difference between the initial point (standing comfortably upright, facing forward, hand in a fist, with the arm extended) and the reaching point (reaching forward as far as possible) without stepping or losing balance. These measured distances were calculated into the average of 3 results.

All subjects provided written informed consent to participate in the study before the health status examination. This study was approved by the Oshima Local Ethics Committee.

Statistical Analysis

Women with missing values for any variables were excluded from analysis ($n=35$), leaving 278 women for the final data analysis. Comparisons of prevalence of fear of falling by age group, and physical performance or pain between subjects with and without fear of falling were performed using the Student's *t*-test for continuous variables or the chi-square test for nominal variables. The association between fear of falling and physical performance measures or pain was assessed using logistic regression analysis, adjusting for age (model 1). As age, BMI, comorbidities, falls in the previous year, and cataracts may be associated with fear of falling, we included all the variables in another model (model 2). The Hosmer–Lemeshow test was used to evaluate the difference between observed and predicted prevalence in our multivariate logistic regression analysis. Odds ratios (OR) and 95% confidence intervals (CI) were calculated. A probability value of $P < 0.05$ was considered to indicate significance. All statistical analyses were performed using SPSS software version 21 (SPSS Inc., Chicago, IL).

RESULTS

The characteristics of the subjects are shown in Table 1. Mean age and BMI were 72.6 years old and 23.5 kg/m², respectively. Of the women, 22% had low back pain, 21% had upper extremity pain, and 37% had lower extremity pain. Twenty-eight percent of the women had at least 1 comorbidity, and 23% reported a history of falls in the previous year.

The prevalence of fear of falling in all subjects was 36.3% (101/278). Table 2 shows the prevalence of fear of falling according to the age group. The prevalence of fear of falling in the > 75 years age group was higher than that of the 65 to 74 years age group, but it was not significant ($P=0.081$).

Table 3 shows a comparison of physical performance or pain between women with fear of falling and those without. Women with fear of falling had poor physical functioning (longer 6-m walking time, longer five-time chair stand time, weaker grip strength and longer TUG) and higher prevalence of pain (low back pain, upper extremity pain and lower extremity pain), compared with women without fear of falling ($P < 0.05$). There was not a significant difference in functional reach among them.

Multivariate logistic regression was performed to assess factors affecting fear of falling in the elderly women (Table 4). The Hosmer–Lemeshow test showed no significant difference between observed and predicted prevalence. After adjustment

TABLE 1. Subject Characteristics ($n=278$)

Variables	Mean \pm SD*	Range
Age (years)	72.6 \pm 5.2	(65–91)
Body mass index (kg/m ²)	23.5 \pm 3.4	(13.3–36.7)
6m walking time (sec)	5.0 \pm 1.5	(3.2–14.3)
5 times chair stand time (sec)	10.5 \pm 4.2	(5.5–44.2)
Grip strength (kg)	22.0 \pm 5.0	(4.0–44.5)
Timed up and go test (s)	9.2 \pm 2.5	(5.0–20.4)
Functional reach (cm)	24.4 \pm 6.3	(7.0–39.3)
		Number (%)
Low back pain		61 (21.9)
Upper extremities pain		57 (20.5)
Lower extremities pain		104 (37.4)
Comorbidity [†]		77 (27.7)
Falls in the previous year		64 (23.0)
Cataract		118 (42.4)

*SD = Standard Deviation.

[†] Presence of heart disease, lung disease, stroke, or diabetes mellitus.

TABLE 2. Prevalence of Fear of Falling by Age Group

Variables	Fear of Falling		P-value
	Yes (n = 101)	No (n = 177)	
Age (years)			
65–74	61 (32.8)	125 (67.2)	0.081
75 over	40 (43.5)	52 (56.5)	

Number (%), Chi-square test.

TABLE 3. Comparison of Physical Performance or Pain Between Subjects with Fear of Falling and Those Without

Variables	Fear of Falling		P-value
	Yes (n = 101)	No (n = 177)	
6m walking time (sec)	5.6 \pm 1.9	4.7 \pm 1.0	<0.001
5 times chair stand time (sec)	12.3 \pm 5.9	9.5 \pm 2.3	<0.001
Grip strength (kg)	20.8 \pm 5.2	22.6 \pm 4.8	0.005
Timed up and go test (sec)	10.4 \pm 3.1	8.5 \pm 1.7	<0.001
Functional reach (cm)	24.1 \pm 6.2	24.6 \pm 6.4	0.537
Low back pain	32 (31.7)	29 (16.4)	0.003
Upper extremities pain	28 (27.7)	29 (16.4)	0.024
Lower extremities pain	51 (50.5)	53 (29.9)	0.001

Mean \pm Standard deviation, number (%). Student's *t*-test for continuous variables; chi-square test for categorical variables.

TABLE 4. Independent Associations with Fear of Falling (n = 278)

Variables	Unit	Model 1 Age Adjusted Odds Ratio (95% CI)	Model 2 Age, BMI, Comorbidity*, Falls and Cataract Adjusted Odds Ratio (95% CI)
6m walking time	1SD [†]	2.21 (1.52–3.19)	1.99 (1.35–2.91)
5 times chair stand	1SD [†]	2.31 (1.57–3.41)	2.11 (1.42–3.15)
Grip strength	–1SD [†]	1.35 (1.00–1.81)	1.38 (1.01–1.87)
Timed up and go test	1SD [†]	2.65 (1.83–3.84)	2.62 (1.76–3.90)
Functional reach	1SD [†]	1.02 (0.79–1.33)	1.08 (0.82–1.41)
Low back pain	yes	2.23 (1.24–4.00)	2.12 (1.16–3.87)
Upper extremities pain	yes	1.92 (1.06–3.49)	1.93 (1.04–3.57)
Lower extremities pain	yes	2.33 (1.40–3.87)	2.06 (1.22–3.49)

BMI = Body mass index, CI = Confidence interval.

* Presence of heart disease, lung disease, stroke, or diabetes mellitus.

[†] SD = Standard Deviation: 6 m walking time (1.5 sec), 5 times chair stand (4.2 sec), Grip strength (5.0 kg), Timed up and go test (2.5 sec), Functional reach (6.3 cm).

for age, poor physical performance (longer 6-m walking time, longer 5-time chair stand time, weaker grip strength, and longer TUG) and pain (low back pain, upper extremity pain, and lower extremity pain) were significantly associated with fear of falling. No association was found between fear of falling and functional reach. Additional adjustment for BMI, comorbidities, falls in previous year, and cataracts did not alter these associations.

DISCUSSION

We found that 36% of the elderly women in the present study had fear of falling. This prevalence increased with age, which was similar to previous reports.^{21–23} The prevalence of fear of falling among community-dwelling elderly women differs between studies with reports of 35% in the United States,⁵ 66% in the Netherlands,²³ and 84% in Korea.²⁴ Variations in the prevalence of fear of falling may be due to differences in population characteristics, such as age distribution, fall history, frailty, or culture.

We found that fear of falling was associated with poor physical performance in walking time, chair stand time, grip strength, and TUG. Park et al¹⁵ reported that elderly with fear of falling had a lower Short Physical Performance Battery score, longer TUG, and weaker grip strength. Rochat et al¹³ reported that fear of falling was associated with reduced gait performance. A decline in physical performance leads to deterioration in the ability to cope with physical challenges on a daily basis and may increase one's fear of falling regardless of previous experience with falls.¹⁵

Previous studies have shown a relationship between fear of falling and decreased muscular strength (decreased grip strength and increased time to perform 5 chair stands).^{12,13} Brouwer et al²⁵ reported that elderly with fear of falling had curtailed their daily activities, which could lead to diminished muscle function. Elderly with muscle weakness may avoid performing activities of daily living, which may further encourage muscle weakness. Muscle weakness may result in perceived vulnerability or loss of confidence when performing everyday activities.²⁵ Although the relative timing of events (declines in strength, activity reduction, and fear of falling) is not known because of the cross-sectional design of the present

study, the relationship between these events could be reciprocal rather than unidirectional.

Several studies reported the relationship between fear of falling and pain.^{26,27} We found that upper extremity, lower extremity, and low back pain were significantly associated with fear of falling. Gillespie et al¹⁷ reported that fearful subjects were more likely to report low back pain and lower extremity arthritis. Pain may increase older adult's risk of developing fear of falling.¹⁸ Clinicians working with older adults with pain should consider assessing fear of falling and, if necessary, intervene if they identify an individual at risk.¹⁸

Several studies reported that impaired balance is associated with fear of falling.^{28,29} Although Kressig et al¹⁶ reported the association between fear of falling and functional reach,³⁰ we found no association between them. Compared with our subjects (mean functional reach were 24.1 cm in women with fear of falling and 24.6 cm in women without fear of falling, respectively), subjects in the study of Kressig et al may be more frail; mean functional reach were 10.34 cm in the fearful group and 11.85 cm in the not fearful group, respectively. The association between fear of falling and functional reach may be found among older adults transitioning to frailty.

Comorbidity, visual impairment, and experiencing a fall were reported to be associated with fear of falling.^{7,10,11,21} Thus, we conducted logistic regression analysis, adjusting for these variables. Because we used cataracts as a surrogate for visual impairment, all visual impairments may not have been identified. Our results might underestimate the associations with fear of falling.

There are limitations to this study. First, in this cross-sectional analysis, a causal relationship was not necessarily shown by our results. Longitudinal studies are required to establish causal relationships between fear of falling and physical performance or pain. Second, the subjects in this study were recruited from community-dwelling residents who voluntarily attended a health examination. Women with poor health were not examined, which might have affected the results. Third, data on depression or cognitive function was not available in our study. These limitations may contribute to the underestimate of the associations. Fourth, the present results were obtained from only Japanese women; therefore, it is not possible to extrapolate the results to men or to other ethnicities.

We showed that poor physical performance and pain were associated with fear of falling in community-dwelling Japanese elderly women. Maintenance of physical functioning and pain management may be important for elderly women with fear of falling.

REFERENCES

- Jorstad EC, Hauer K, Becker C, et al. Measuring the psychological outcomes of falling: a systematic review. *J Am Geriatr Soc.* 2005;53:501–510.
- Bruce DG, Devine A, Prince RL: recreational physical activity levels in healthy older women: the importance of fear of falling. *J Am Geriatr Soc.* 2002;50:84–89.
- Tinetti ME, Mendes de Leon CF, Doucette JT, et al. Fear of falling and fall-related efficacy in relationship to functioning among community-living elders. *J Gerontol.* 1994;49:M140–M147.
- Cumming RG, Salkeld G, Thomas M, et al. Prospective study of the impact of fear of falling on activities of daily living, SF-36 scores, and nursing home admission. *J Gerontol A Biol Sci Med Sci.* 2000;55:M299–305.
- Arfken CL, Lach HW, Birge SJ, et al. The prevalence and correlates of fear of falling in elderly persons living in the community. *Am J Public Health.* 1994;84:565–570.
- Howland J, Lachman ME, Peterson EW, et al. Covariates of fear of falling and associated activity curtailment. *Gerontologist.* 1998;38:549–555.
- Aoyagi K, Ross PD, Davis JW, et al. Falls among community-dwelling elderly in Japan. *J Bone Miner Res.* 1998;13:1468–1474.
- Suzuki M, Ohyama N, Yamada K, et al. The relationship between fear of falling, activities of daily living and quality of life among elderly individuals. *Nurs Health Sci.* 2002;4:155–161.
- Murphy SL, Williams CS, Gill TM: Characteristics associated with fear of falling and activity restriction in community-living older persons. *J Am Geriatr Soc.* 2002;50:516–520.
- Scheffer AC, Schuurmans MJ, van Dijk N, et al. Fear of falling: measurement strategy, prevalence, risk factors and consequences among older persons. *Age Ageing.* 2008;37:19–24.
- Kempen GI, van Haastregt JC, McKee KJ, et al. Socio-demographic, health-related and psychosocial correlates of fear of falling and avoidance of activity in community-living older persons who avoid activity due to fear of falling. *BMC Public Health.* 2009;9:170.
- Deshpande N, Metter EJ, Bandinelli S, et al. Psychological, physical, and sensory correlates of fear of falling and consequent activity restriction in the elderly: the InCHIANTI study. *Am J Phys Med Rehabil.* 2008;87:354–362.
- Rochat S, Bula CJ, Martin E, et al. What is the relationship between fear of falling and gait in well-functioning older persons aged 65 to 70 years? *Arch Phys Med Rehabil.* 2010;91:879–884.
- Oya T, Uchiyama Y, Shimada H, et al. Factors associated with fear of falling among community-dwelling elderly adults without reduced performance in instrumental activities of daily living. *Nihon Ronen Igakkai Zasshi.* 2012;49:457–462.
- Park JH, Cho H, Shin JH, et al. Relationship among fear of falling, physical performance, and physical characteristics of the rural elderly. *Am J Phys Med Rehabil.* 2014;93:379–386.
- Kressig RW, Wolf SL, Sattin RW, et al. Associations of demographic, functional, and behavioral characteristics with activity-related fear of falling among older adults transitioning to frailty. *J Am Geriatr Soc.* 2001;49:1456–1462.
- Gillespie SM, Friedman SM: dear of falling in new long-term care enrollees. *J Am Med Dir Assoc.* 2007;8:307–313.
- Stubbs B, West E, Patchay S, et al. Is there a relationship between pain and psychological concerns related to falling in community dwelling older adults? *Syst Rev Disabil Rehabil.* 2014.
- Champagne A, Prince F, Bouffard V, et al. Balance, falls-related self-efficacy, and psychological factors amongst older women with chronic low back pain: a preliminary case-control study. *Rehabil Res Pract.* 2012;2012:430374.
- Kanagae M, Abe Y, Honda S, et al. Determinants of self-rated health among community-dwelling women aged 40 years and over in Japan. *Tohoku J Exp Med.* 2006;210:11–19.
- Bertera EM, Bertera RL: fear of falling and activity avoidance in a national sample of older adults in the United States. *Health Soc Work.* 2008;33:54–62.
- Evitt CP, Quigley PA: fear of falling in older adults: a guide to its prevalence, risk factors, and consequences. *Rehabil Nurs.* 2004;29:207–210.
- Zijlstra GA, van Haastregt JC, van Eijk JT, et al. Prevalence and correlates of fear of falling, and associated avoidance of activity in the general population of community-living older people. *Age Ageing.* 2007;36:304–309.
- Kim S, So WY: prevalence and correlates of fear of falling in Korean community-dwelling elderly subjects. *Exp Gerontol.* 2013;48:1323–1328.
- Brouwer B, Musselman K, Culham E: physical function and health status among seniors with and without a fear of falling. *Gerontology.* 2004;50:135–141.
- Hubscher M, Vogt L, Schmidt K, et al. Perceived pain, fear of falling and physical function in women with osteoporosis. *Gait Posture.* 2010;32:383–385.
- Martin FC, Hart D, Spector T, et al. Fear of falling limiting activity in young-old women is associated with reduced functional mobility rather than psychological factors. *Age Ageing.* 2005;34:281–287.
- Maki BE, Holliday PJ, Topper AK: fear of falling and postural performance in the elderly. *J Gerontol.* 1991;46:M123–M131.
- Austin N, Devine A, Dick I, et al. Fear of falling in older women: a longitudinal study of incidence, persistence, and predictors. *J Am Geriatr Soc.* 2007;55:1598–1603.
- Duncan PW, Weiner DK, Chandler J, et al. Functional reach: a new clinical measure of balance. *J Gerontol.* 1990;45:M192–M197.