whether a subjective risk evaluation of falls is more valuable than other assessment measures in relating falls in frail elderly adults.

## SUBJECTS AND METHODS

The study included 232 elderly people (48 men, 184 women, mean age 82.8 ± 6.3 years) who had received certification for long-term care, and who used day-care services between September 2009 and March 2010. Exclusion criteria were as follows: heart attack or stroke within the previous 6 months, acute inflammation, systolic blood pressure ≥180 mmHg or diastolic blood pressure ≥110 mmHg, resting heart rate ≥120, severe cognitive impairment (mental status questionnaire (MSQ) score 9 to 10), or an order by a general practitioner to stop all physical activity. General practitioners ruled on participation in the study by subjects with any of the following conditions: cerebrovascular disease, Alzheimer's disease, heart disease, diabetes, orthopaedic pain and neurological symptoms. Table 1 shows the characteristics of the study subjects. The ethical consideration in this study was secured by performing the study after having received the approval of the Ethical Review Board of Tokyo Metropolitan Institute of Gerontology, and the contents of this research was based on the Declaration of Helsinki.

**Table 1.** Characteristics of the subjects

| Demographic variables | n = 232 |
|---|---|
| Age (years) | 82.8 ± 6.3 |
| Sex (female) | 184 (79.3) |
| Category of Japanese Long-Term Care Insurance | |
| Support Level 1 | 30 (12.9) |
| Support Level 2 | 50 (21.6) |
| Care Level 1 | 75 (32.3) |
| Care Level 2 | 48 (20.7) |
| Care Level 3 | 24 (10.3) |
| Care Level 4 | 5 (2.2) |
| Care Level 5 | 0 (0) |
| Primary diseases or general health status | |
| History of stroke (yes) | 26 (11.2) |
| Parkinson disease (yes) | 13 (5.6) |
| Knee osteoarthritis with pain (yes) | 76 (32.8) |
| Poor vision (yes) | 14 (6.0) |
| Urinary incontinence or frequency (yes) | 64 (27.6) |
| Psychotropic use (yes) | 79 (34.1) |
| Walking aid use (yes) | 99 (42.7) |
| Physical performances | |
| Chair Stand Test (s) | 12.5 ± 5.2 |
| Timed Up and Go test (s) | 15.6 ± 8.5 |
| Behavioural variables | |
| Absence of habitual exercise (yes) | 126 (54.3) |
| Daily use of slippers or sandals (yes) | 70 (30.2) |

Variables presented as mean ± standard deviation, or number (%)

The subjective risk rating of specific tasks (SRRST) was conducted by day-care center staff who had nursing, allied health or similar qualifications. Prior to the commencement of the study, all staff received a manual which set out correct protocols for administering all the assessment measures included in the study. The raters of the SRRST were limited to the care staff who well knew the ADL status of their clients. The SRRST consisted of the following items: 1) "Do you feel there is a risk of falls when the client (Mr or Mrs X) is walking?"; 2) "Do you feel there is a risk of falls when the client is transferring to the bedroom, toilet, or bathroom?"; 3) "Do you feel there is a risk of falls when the client is toileting?"; 4) "Do you feel there is a risk of falls when the client is ascending or descending stairs?"; 5) "Do you feel there is a risk of falls when the client is wandering?"; 6) "Do you feel there is risk of falls because the client exhibits risky behavior?"; 7) "Do you feel there is a risk of falls because the client is agitated?". The responses to each item in the SRRST were designated as "yes" (1 point) or "no or not applicable" (0 point). The SRRST and history of falls were obtained at the same time. Prior to the commencement of the study, three assessors completed the SRRST twice at weekly intervals for 30 subjects (n = 3 × 2 × 30), and the test-retest and inter-rater reliability comparisons of total scores revealed intraclass correlation coefficients (ICCs) of 0.91 (ICC 1, 1) and 0.85 (ICC 2, 3), respectively.

A fall was defined as "an event that resulted in a person coming to rest unintentionally on the ground or another lower level that did not result from a major intrinsic event or an overwhelming hazard"[12,13]. Falls and fall-related fractures were measured retrospectively for a 1 year period via a self-report questionnaire. A caregiver or family member provided information on the participant's annual incidence of falls and fall-related fractures when the trained nurses or care workers recognized that a participant had problems recalling such events.

With reference to previous studies[14–18], we selected two demographic variables, seven primary diseases or general health statuses, two physical performance tests, and two behavioural variables as possible confounding factors for falls (Table 2). The demographic variables were sex and age. Primary diseases or general health status were recorded by the care staff, who identified the chronic condition from care records or symptoms. The following diseases and general health status were included in the analysis: history of stroke with symptoms of hemiparesis, knee osteoarthritis with pain, Parkinson's disease, poor vision, urinary incontinence or frequency, psychotropic use, and walking aid use. Physical performances were measured using chair stand test (CST) and timed 'up & go' test (TUG). The CST was used as an index to reflect the strength of the legs[19]. The time required for standing up and sitting down five times as fast as possible was measured twice, with the quickest value taken as the representative value. The TUG

Table 2. Comparison of all measures between the fallers and non-fallers

| | Fallers (n = 81) | Non-fallers (n = 151) |
|---|---|---|
| Age (years) | 83.4 ± 6.6 | 82.5 ± 6.1 |
| Sex (female) | 64 (79.0) | 120 (79.5) |
| Category of Japanese Long-Term Care Insurance (care level 3 to 5) | 14 (17.3) | 15 (9.9) |
| History of stroke (yes) | 9 (11.1) | 17 (11.3) |
| Parkinson disease (yes) | 3 (3.7) | 10 (6.6) |
| Knee osteoarthritis with pain (yes) | 31 (38.3) | 45 (29.8) |
| Poor vision (yes) | 5 (6.2) | 9 (6.0) |
| Urinary incontinence or frequency (yes) | 31 (38.3) | 33 (21.9) ** |
| Psychotropic use (yes) | 27 (33.3) | 52 (34.4) |
| Walking aid use (yes) | 43 (53.1) | 56 (37.1)* |
| Chair Stand Test (sec) | 12.6 ± 5.7 | 12.4 ± 5.0 |
| Timed Up and Go test (sec) | 17.1 ± 10.0 | 14.9 ± 7.5 |
| Absence of habitual exercise (yes) | 47 (58.0) | 79 (52.3) |
| Daily use of slippers or sandals (yes) | 27 (33.3) | 43 (28.5) |
| SRRST (points) | 3.1 ± 1.8 | 2.2 ± 2.0** |

*$p < 0.05$; **$p < 0.01$. SRRST: subjective risk rating of specific tasks

Table 3. Relationship between history of falls and potential risk factors of falls

| | Odds ratio | 95% CI |
|---|---|---|
| Age (years) | 1.01 | 0.97 - 1.06 |
| Sex (female) | 0.89 | 0.43 - 1.85 |
| Category of Japanese Long-Term Care Insurance (care level 3 to 5) | 1.52 | 0.65 - 3.57 |
| History of stroke (yes) | 1.60 | 0.63 - 4.05 |
| Parkinson disease (yes) | 2.99 | 0.67 - 13.32 |
| Knee osteoarthritis with pain (yes) | 1.05 | 0.54 - 2.04 |
| Poor vision (yes) | 1.35 | 0.39 - 4.76 |
| Urinary incontinence or frequency (yes) | 0.58 | 0.29 - 1.15 |
| Psychotropic use (yes) | 0.96 | 0.51 - 1.79 |
| Walking aid use (yes) | 0.68 | 0.35 - 1.30 |
| Chair Stand Test (sec) | 0.96 | 0.91 - 1.03 |
| Timed Up and Go test (sec) | 1.02 | 0.98 - 1.06 |
| Absence of habitual exercise (yes) | 1.33 | 0.68 - 2.63 |
| Daily use of slippers or sandals (yes) | 0.80 | 0.43 - 1.52 |
| SRRST (points) | 1.22 | 1.03 - 1.45* |

*: $p < 0.05$

is a movement ability test for elderly people advocated by Podsiadlo et al.[20] and applies the Get-up and Go test by Mathias et al.[21] which measures the speed of accomplishing a round trip of a 3 m walking distance from a seated position. Absence of habitual exercise and daily use of slippers or sandals were investigated as behavioural variables.

To examine group differences in measurements regarding experience of falls during the previous year, we performed an analysis by the Student t-test and the chi-square test. In addition, to clarify independent risk factors regarding falls, a multiple logistic regression analysis was performed with falls as the dependent variable, and the SRRST and possible confounding factors as the independent variables, and the odds ratio (OR) was calculated. The statistical analysis was performed using PASW Statistics 18, and the significant level was set at 5%.

## RESULTS

Eighty one subjects had fallen during the previous year (34.9%). In the group comparison between the subjects with and without the falls, the faller group showed significantly higher rates in urinary incontinence or frequency (faller 38.3%, non-faller 21.9%) and walking aid use (faller 53.1%, non-faller 37.1%), and a higher SRRST than the non-faller group (faller 3.1 ± 1.8, non-faller 2.2 ± 2.0) (Table 2).

The multiple logistic regression models revealed a significant relationship between falls and SRRST while possible confounding factors were not significant (Table 3). The OR of the SRRST score was 1.22 (95% confidence interval (95% CI); 1.03 - 1.45) for falls.

## DISCUSSION

In the comparison of fallers and non-fallers, the fallers were found to have higher rates of urinary incontinence and frequency than the non-fallers. Regarding the relationship between urinary incontinence and urinary frequency and falling, we hypothesize that the elderly might trip when they rush to the toilet trying to avoid incontinence[22]. The fallers were more likely to use a walking aid than the non-fallers, although physical performances, i.e., the CST and TUG, were not different between the fallers and non-fallers. The results suggest that the subjects experiencing falls used a walking aid as a strategy to prevent falls while maintaining good physical performances. However, a walking aid may not prevent falls by those with an imbalance between physical capacity and physical activity level. Those with the highest activity levels had a significant lower risk of falls, but those with intermediate levels had no reduced risk of falls[23].

In the multiple logistic model adjusted for all confounding factors, only SRRST was associated independently with falls in our frail elderly subjects. Furthermore, the SRRST had some advantages compared with objective measurements. The SRRST can be evaluated in a short period, and may be used to draw attention to ADLs with high risks. Shimada et al. reported previously on an enhanced supervision approach based on a subjective risk rating method for the prevention of falls among institutionalized elderly people[24]. A falls prevention intervention reduced the number of fallers and fall rates in the frail elderly adults through close supervision, active interventions, and environmental modifications of targeted fall-risk factors. The SRRST may be a basic assessment tool for identifying the need for an enhanced supervision approach in the frail elderly people. However, future studies need to determine whether the significant relationship between the SRRST score and falls in a longitudinal study is confirmed in a prospective investigation.

In conclusion, the SRRST was significantly associated with falls in frail elderly adults, while potential confounding factors did not have a significant association. The subjective risk rating of falls in the frail elderly may be useful for determining which tasks have a fall risk and interventions, such as the supervision approach.

## REFERENCES


1) Rubenstein LZ, Josephson KR, Robbins AS: Falls in the nursing home. Ann Intern Med, 1994, 121: 442–451.
2) Suzukawa M, Shimada H, Makizako H, et al.: Incidence of falls and fractures in disabled elderly people utilizing long-term care insurance. Nippon Ronen Igakkai Zasshi, 2009, 46: 334–340.
3) Suzuki T, Sugiura M, Furuna T, et al.: Association of physical performance and falls among the community elderly in Japan in a five year follow-up study. Nippon Ronen Igakkai Zasshi, 1999, 36: 472–478.
4) Takeda H, Kamogawa J, Sakayama K, et al.: Evaluation of clinical prognosis and activities of daily living using functional independence measure in patients with hip fractures. J Orthop Sci, 2006, 11: 584–591.
5) Moreland J, Richardson J, Chan DH, et al.: Evidence-based guidelines for the secondary prevention of falls in older adults. Gerontology, 2003, 49: 93–116.
6) Pomeroy VM, Warren CM, Honeycombe C, et al.: Mobility and dementia: Is physiotherapy treatment during respite care effective? Int J Geriatr Psychiatry, 1999, 14: 389–397.
7) Cameron ID, Murray GR, Gillespie LD, et al.: Interventions for preventing falls in older people in nursing care facilities and hospitals. Cochrane Database Syst Rev, 2010: CD005465.
8) Shimada H, Suzukawa M, Tiedemann A, et al.: Which neuromuscular or cognitive test is the optimal screening tool to predict falls in frail community-dwelling older people? Gerontology, 2009, 55: 532–538.
9) Lundin-Olsson L, Jensen J, Nyberg L, et al.: Predicting falls in residential care by a risk assessment tool, staff judgement, and history of falls. Aging Clin Exp Res, 2003, 15: 51–59.
10) Izumi K, Makimoto K, Kato M, et al.: Prospective study of fall risk assessment among institutionalized elderly in Japan. Nurs Health Sci, 2002, 4: 141–147.
11) Nordin E, Lindelof N, Rosendahl E, et al.: Prognostic validity of the timed up-and-go test, a modified get-up-and-go test, staff's global judgement and fall history in evaluating fall risk in residential care facilities. Age Ageing, 2008, 37: 442–448.
12) Nevitt MC, Cummings SR, Kidd S, et al.: Risk factors for recurrent nonsyncopal falls. A prospective study. JAMA, 1989, 261: 2663–2668.
13) Cumming RG, Sherrington C, Lord SR, et al.: Cluster randomised trial of a targeted multifactorial intervention to prevent falls among older people in hospital. BMJ, 2008, 336: 758–760.
14) Lord SR SC, Menz HB, Close JCT: Falls in older people: risk factor and strategies for prevention (2nd ed). Cambridge: Cambridge University Press, 2007.
15) Rubenstein LZ, Josephson KR: The epidemiology of falls and syncope. Clin Geriatr Med, 2002, 18: 141–158.
16) Tinetti ME, Speechley M, Ginter SF: Risk factors for falls among elderly persons living in the community. N Engl J Med, 1988, 319: 1701–1707.
17) Fleming BE, Pendergast DR: Physical condition, activity pattern, and environment as factors in falls by adult care facility residents. Arch Phys Med Rehabil, 1993, 74: 627–630.
18) Kiely DK, Kiel DP, Burrows AB, et al.: Identifying nursing home residents at risk for falling. J Am Geriatr Soc, 1998, 46: 551–555.
19) Csuka M, McCarty DJ: Simple method for measurement of lower extremity muscle strength. Am J Med, 1985, 78: 77–81.
20) Podsiadlo D, Richardson S: The timed "up & go": a test of basic functional mobility for frail elderly persons. J Am Geriatr Soc, 1991, 39: 142–148.
21) Mathias S, Nayak US, Isaacs B: Balance in elderly patients: the "get-up and go" test. Arch Phys Med Rehabil, 1986, 67: 387–389.

22) Brown JS, Vittinghoff E, Wyman JF, et al.: Urinary incontinence: does it increase risk for falls and fractures? Study of Osteoporotic Fractures Research Group. J Am Geriatr Soc, 2000, 48: 721–725.
23) Graafmans WC, Lips P, Wijlhuizen GJ, et al.: Daily physical activity and the use of a walking aid in relation to falls in elderly people in a residential care setting. Z Gerontol Geriatr, 2003, 36: 23–28.
24) Shimada H TA, Lord SR, Suzuki T: The effect of enhanced supervision on fall rates in residential aged care. Am J Phys Med Rehabil, 2009, 88: 823–828.

J.Phys. Ther. Sci
23: 443-449, 2011

# The Relationship Between Pulmonary Function and Physical Function and Mobility in Community-Dwelling Elderly Women Aged 75 Years or Older

TSUTOMU ABE, RPT, MS[1-3], TAKAO SUZUKI, MD, PhD[4], HIDEYO YOSHIDA, MD, PhD[5], HIROYUKI SHIMADA, RPT, PhD[4], NOBUO INOUE, PhD[1]

[1] *Department of Frontier Health Sciences, Tokyo Metropolitan University*
[2] *Department of Health Science, Uekusagakuen University*
[3] *Itabashi Rehabilitation Home-visiting Nursing Station: 2–11 Hikawa-cho, Itabashi-ku, Tokyo, 173-0013 Japan. TEL: +81 3-5943-3151, FAX: +81 3-5943-3152, E-mail: iamatomu@yahoo.co.jp*
[4] *National Center for Geriatrics and Gerontology*
[5] *Tokyo Metropolitan Institute of Gerontology*

**Abstract.** [Purpose] The purpose of the present study was to evaluate the relationship between pulmonary function and the physical function and mobility of community-dwelling elderly women aged ≥75 years. [Methods] The subjects were 1,022 women aged ≥75 years who were living in an urban environment. We measured their vital capacity (VC) and forced expiratory volume in 1 s (FEV1.0) by spirometry, and assessed their physical function and mobility. [Results] Older women exhibited inferior pulmonary function as well as reduced physical function and mobility. These findings highlight the impact of diminished pulmonary function on physical function in old age. [Conclusions] Women of advanced age have diminished pulmonary function, physical function, and mobility, and diminished pulmonary function is associated with declining physical function. When an examination is required, spirometry should be included as an examination modality for its diagnostic value.
**Key words:** Pulmonary function, Physical function and mobility, Elderly women

*(This article was submitted Nov. 15, 2010, and was accepted Dec. 16, 2010)*

## INTRODUCTION

An investigation that estimated the characteristics of population dynamics in Japan over the next 50 years reported that only the proportion of elderly individuals aged ≥75 years is expected to increase in the near future[1]. We have never experienced so great an aging of the population in our society which is facing a future of relatively fewer children as well as a decline in the population . Among the elderly population aged ≥75 years, declines in psychosomatic and vital functions frequently appear with aging. In particular, because women have a longer average life span, they will require healthcare for longer and the major reason for this is that the age-related changes in the muscular and skeletal systems are more remarkable in women than in men[2].

Older individuals are severely affected with regard to the performance of activities of daily living (ADL) due to a decline in physical function[3–5].

Many physiological functions deteriorate with increasing age, and pulmonary function is no exception. It is very important that we understand the physiological changes seen in the lungs with aging[10,11] as pulmonary function deteriorates linearly with age[12]. Respiratory effort increases with age due to costochondral calcification. In addition, elastic tissues in the lungs, such as in the alveoli, are degraded and the lungs expand[13–15]. Therefore, although the total lung capacity remains unchanged, the residual volume increases with age[16–18]. Furthermore, the maximum expiratory and inspiratory muscular strengths deteriorate with increasing age[19–21]. In addition spirometric measurements have shown that both vital capacity (VC) and forced expiratory volume in 1 s (FEV1.0) decline with age[22–24].

Functional disorders negatively affect physical function and mobility, and it is generally acknowledged that diminishing physical function and mobility influence the quality of life[25]. Studies of physical function of the elderly are becoming more important[6–9]. Regarding the evaluation of the physical function of the elderly, diminished capabilities are commonly encountered in hand-grip strength, gait velocity, timed up-and-go (TUG) at a comfortable speed, and one leg standing time with eyes open. However, the contribution of pulmonary function to the decline in physical function has not been evaluated in any detail. As a result, the relationship between diminishing pulmonary function and physical function and mobility among the elderly population remains unclear.

The purpose of the present study was to evaluate the relationships between pulmonary function and physical function and mobility of community-dwelling elderly women aged ≥75 years.

## SUBJECTS AND METHODS

*Subjects*

We performed systematic comprehensive mass health examinations for elderly women living in the community in order to devise new strategies to increase physical fitness and to prevent the need for long-term care[2]. The participants in the examinations conducted in November 2008 were women aged ≥75 years who were living in Itabashi-ku, Tokyo at that time. From among 1,289 women who provided consent, we included 1,022 women in the present study for whom complete data were available. For the examination, we invited each participant to a meeting and conducted a medical examination and verbal interview. After receiving an explanation of the nature of the study and evaluation methods, all subjects provided their informed consent to voluntarily participate. This study was approved by the Ethical Review Board of Tokyo Metropolitan Institute of Gerontology.

*Methods*

We measured VC and FEV1.0 by spirometry, and assessed physical function and mobility. We divided the participants by age into two groups (75–79 years and 80–84 years) and compared each measurement result between these groups to examine the influence of age. We also classified pulmonary functional disorders roughly into four categories based on ventilatory characteristics: 1) Normal; 2) Narrowing of the bronchi, and obstructive ventilatory impairment with inadequate expiration; 3) Restrictive ventilatory impairment with inadequate air intake due to insufficient thoracic movement; and 4) A mixed type of the disorders described in 2) and 3). We used these categories to compare each measurement result and examined the influence of these pulmonary functional disorders on the results.

The technical characteristics of the instruments used in addition to the training of technicians are important for obtaining reliable results and for quality control of spirometry. Staff members were specifically trained and received lectures aimed at teaching and reviewing the rationale and practice of spirometric procedures. All pulmonary function tests used in the present study were performed in accordance with the prescribed guidelines[26]. Spirometry was performed using a Chest MI Spirometer (HI-801; Chest, Tokyo, Japan). Each study participant was informed about the methods used for measurements and was given an explanation of the procedures of the examination along with appropriate practice. Spirometric maneuvers were performed with the participants seated in a comfortable position, wearing a nose clip, and the participants expired air was fed to the spirometer via a mouthpiece. All technicians were instructed to perform a minimum of two maneuvers to ensure that the participants produced the highest possible peak flow rates. Participant's VC and FEV1.0 were measured after a rest period of several minutes between maneuvers. Satisfactory exhalation was considered to have been achieved if 1) there was no change in the exhaled volume (plateau on the volume-time curve) for 1 s after an exhalation time of at least 6 s, 2) there was a reasonable duration or plateau in the volume-time curve, or 3) the participant was unable to continue to exhale. The spirometer automatically made the following calculations. Predicted VC = [0.032 × height (cm) – 0.018 × age – 1.178]. From the result obtained, %VC = [VC (measured)/VC (predicted)] × 100 and %FEV1.0 = (FEV1.0 /FVC) × 100, where FVC indicates forced VC. We used %VC and %FEV1.0 for analysis.

The participants also underwent tests for hand-grip strength, knee joint extension strength, comfortable and maximal gait velocities, TUG at comfortable and maximal speeds, and one-leg standing time with eyes open. We evaluated hand-grip strength of the dominant hand with a hand-held dynamometer (TKK5401, Hata Company) and isometric contraction of knee joint extension on the dominant side with a mechanical dynamometer (F1, Anima Company). To test knee joint extension strength, we asked the participants to extend the knee joint through 90 degrees to the best of their ability. To test walking velocity, we asked the participants to walk on a straight and flat walkway, 11 m in length, once at their usual speed and once again at their maximum speed. Walking velocity was measured over a 5 m distance between marks at 3 m and 8 m marked from the end of the walkway. To test TUG[27], we asked participants to stand up from a chair, walk 3 m, turnaround and walk another 3 m, and then sit down on the chair. This task was performed once at the participants' usual speed and then again at their maximum speed. The TUG test was measured as a series of movements using a stopwatch. For the one leg standing time with eyes open, we asked participants to look straight ahead at a spot 1 m in front of them. We then asked them to stand on their preferred leg with their eyes open and hands dangling freely alongside their body. The time until balance was lost, up to a maximum of 60 s, was recorded. We used the better of two trials for analysis.

We used the Life-Space Assessment (LSA) as an index of mobility[28]. LSA is used to assess mobility associated with physical function, health condition, and instrumental ADL (IADL), which are necessary for evaluating the mobility of older individuals[29]. LSA is used to identify the distance over which a person reports moving during the 4 weeks prior to the assessment. The LS zones range from a person's bedroom to beyond their home town. Specific questions are: 1) "During the past 4 weeks, have you been to other rooms of your home besides the room where you sleep?" (level 1) 2) "During the past 4 weeks, have you been to an area immediately outside your home, such as your porch, deck, or patio, to the hallway of an apartment building, or garage?" (level 2) 3) "During the past 4 weeks, have you been to places in your immediate neighborhood, but beyond your own property or apartment building?" (level 3) 4) "During the past 4 weeks, have you been to places outside your immediate neighborhood but within your town?" (level 4) and 5) "During the past 4 weeks, have you been to places outside your immediate town?" (level 5) For each LS level, participants were asked how often they traveled to the particular area (<once a week, 1–3 times each week, 4–6 times each week, daily) and whether they needed assistance from another person or from an assistive device ("yes" or "no"). LSA was scored by assigning a value to each of the five levels and then adding the scores of each level. The level scores were obtained by multiplying the level number (1–5) by a value for independence (2 = "no assistance," 1.5 = "use of equipment only," 1 = "use of another person and/or equipment") further multiplied by a value for the frequency of movement (1 = once a week, 2 = 1–3 times each week, 3 = 4–6 times each week, and 4 = daily) The LSA scores ranges from 0 ("totally bed-bound") to 120 ("traveled out of town every day without assistance").

Data on ADL were collected by interviewing the participants. IADL was assessed using a subscale of the Tokyo Metropolitan Institute of Gerontology index of competence, which contains five questions concerning "Instrumental self-maintenance" (shopping for daily living, preparing meals, paying bills, managing bank deposits and savings, and utilizing public transportation)[30]. The response to each item is "yes" (able to do) or "no" (unable). The total score is the number of items answered with a "yes." Thus, a higher score indicates a higher functional capacity.

Data were analyzed using SPSS software (Version 10.4; SPSS Inc., Chicago, IL).

The subjects were divided into two age groups: 75–79-year-olds and 80–84-year-olds. We used a $\chi^2$ test to compare certifications of need for long-term care, presence of disease, IADL, and LSA, and non-paired t-tests to compare other variables.

We classified pulmonary functional impairments into four categories based on ventilatory characteristics. Obstructive ventilatory impairment (OVI) was defined as %FEV1.0 < 70%, restrictive ventilatory impairment (RVI) as %VC < 80%, combined ventilatory impairment (CVI) as %FEV1.0 < 70% and %VC < 80%, and normal ventilatory capacity (NVC) as %FEV 1.0 ≥ 70% and %VC ≥ 80%. We compared the characteristics, the physical function, and mobility between the ventilatory function categories by one-way analysis of variance (ANOVA). When ANOVA indicated a significant effect, we used the Bonferroni post hoc test.

A p-value of <0.05 was considered to indicate statistical significance.

## RESULTS

Table 1 presents the subject characteristics of the study participants. The height, body weight and grip strength of the subjects were similar to the national average[31]. Accordingly, there was no regional deviation from the

**Table 1.** Characteristics of study subjects

| Age (years) | 75–79 | 80–84 |
|---|---|---|
| Number | 661 | 361 |
| Height (cm) | 148.5±5.4 | 146.9±5.6 |
| Body weight (kg) | 50.3±7.7 | 48.9±7.9 |
| BMI (kg/m$^2$) | 22.8±3.5 | 22.7±4.6 |
| SBP (mmHg) | 138.9±18.9 | 139.0±19.6 |
| DBP (mmHg) | 76.8±10.3 | 75.1±10.6 |
| Pulse (beats/min) | 77.6±10.8 | 78.7±10.9 |
| Certification of care need | 51(7%) | 73(20%)** |
| Contraction of disease | | |
| High blood pressure | 350 (53%) | 206 (57%) |
| Hyperlipemia | 259 (39%) | 134(37%) |
| Anemia | 12 (2%) | 13 (4%) |
| Apoplexy | 26 (4%) | 25 (7%) |
| Diabetes | 58 (9%) | 29 (8%) |
| Heart disease | 88 (13%) | 60(17%) |
| Osteoarthritis of the knee | 136 (21%) | 92 (26%) |
| Osteoporosis | 187 (28%) | 132 (37%)** |

BMI: Body Mass Index
SBP: Systolic Blood Pressure
DBP: Diastolic Blood Pressure

mean ± standard deviation
**: p<0.01

**Table 2.** Physical function and mobility of study subjects

| Age (years) | 75–79 | 80–84 |
|---|---|---|
| Number | 661 | 361 |
| Instrumental activity of daily living | 4.7±0.6 | 4.5±0.9** |
| Life Space Assesment | 91.8±15.4 | 85.2±18.4** |
| Grip strength(kg) | 19.0±4.0 | 17.3±4.2** |
| Knee joint extension strength (newton•meter/kg) | 1.2±0.3 | 1.1±0.3** |
| Comfortable gait velocity (meter/second) | 1.3±0.2 | 1.1±0.3** |
| Maximal gait velocity (meter/second) | 1.7±0.3 | 1.4±0.3** |
| Timed up-and-go (second) | 9.5±2.6 | 11.3±4.0** |
| Maximal Timed up and go (second) | 6.9±1.6 | 8.1±2.0** |
| One leg standing time with eyes open (second) | 29.6±22.0 | 19.7±19.6** |

mean ± standard deviation
**: p<0.01

**Table 3.** Pulmonary function of study subjects

| Age (years) | 75–79 | 80–84 |
|---|---|---|
| Number | 661 | 361 |
| VC (L) | 2.1±0.4 | 1.9±0.4** |
| Predicted VC (L) | 2.1±0.02 | 2.0±0.02 |
| %VC (%) | 99.8±18.3 | 96.5±19.7** |
| FEV1.0 (L) | 1.5±0.4 | 1.3±0.3** |
| FVC (L) | 1.8±0.4 | 1.6±0.4** |
| %FEV1.0 (%) | 83.9±11.1 | 81.9±11.7** |

mean ± standard deviation
**: p<0.01

VC: vital capacity
Predicted VC=0.032×height(cm)–0.018×age–1.178
%VC=VC/Predicted VC(0.032×height(cm)–0.018×age–1.178)×100
FEV1.0: forced expiratory volume in 1 second
FVC:forced vital capacity
%FEV 1.0=FEV1.0 /FVC×100

national average. The frequencies of certification of care need and osteoporosis were significantly higher in the group aged 80–84 years than the group aged 75–79 years (p<0.01). Table 2 presents the results of physical functions and mobility tests and Table 3 shows the pulmonary function results. For all the measured variables in these tables, the group aged 80–84 years showed significantly inferior results compared to the group aged 75–79 years (p<0.01).

Table 4 lists the participants' physiological characteristics and the results of mobility assessments determined according to ventilatory function categories. Ventilatory function did not significantly affect the subject' physiological characteristics or mobility. Table 5 presents the results of the physical function tests as per ventilatory function category. Ventilatory function had statistically significant effects on the physical function as evidenced by one-way ANOVA. From the results of post hoc tests, the ventilatory disorder categories of RVI and CVI were found to be significantly associated with worse outcomes than the NVC and OVI disorder categories for many of the physical results.

## DISCUSSION

Medical examinations of the elderly individuals generally serve the purpose of a screening examination for geriatric syndrome involving physical function, mobility, cognitive ability, and nutritional status. It has been hypothesized that the clinical deterioration of physical function and mobility are associated with pulmonary functional disorders. However, very few measurement variables for elucidating the functional integrity of the cardiac and pulmonary systems are known. In recent years,

**Table 4.** Influence of ventilatory function on mobility

| ventilatory functions | Normal Ventilatory Capacity | Obstructive Ventilatory Impairment | Restructive Ventilatory Impairment | Combined Ventilatory Impairment |
|---|---|---|---|---|
| Number | 791 | 73 | 136 | 22 |
| Age | 78.3±2.6 | 78.7±2.7 | 78.9±2.8 | 78.7±2.7 |
| Height (cm) | 148.2±5.4 | 148.7±5.8 | 146.5±5.6 | 145.6±4.7 |
| Body weight (kg) | 50.1±7.5 | 49.2±7.5 | 48.7±8.5 | 45.6±9.3 |
| BMI (kg/m$^2$) | 22.6±4.7 | 22.4±5.2 | 22.1±4.7 | 21.7±5.6 |
| SBP (mmHg) | 139.4±18.8 | 137.8±20.3 | 137.9±20.2 | 134.4±21.5 |
| DBP (mmHg) | 76.6±10.2 | 75.9±10.7 | 74.6±10.9 | 72.1±12.6 |
| Pulse (beats/min) | 78.3±10.9 | 77.9±9.9 | 75.7±10.5 | 78.8±11.1 |
| Instrumental activity of daily living | 4.6±0.8 | 4.6±0.7 | 4.5±0.9 | 4.5±0.6 |
| Life Space Assesment | 89.9±16.8 | 92.2±13.4 | 86.2±17.7 | 84.8±18.6 |

Obstructive Ventilatory Impairment: %FEV 1.0<70%
Restructive Ventilatory Impairment: %VC<80%
Combined Ventilatory Impairment: %FEV 1.0<70% and %VC<80%

mean ± standard deviation

**Table 5.** Influence of ventilatory functions on physical function

| Ventilatory function | Normal Ventilatory Capacity | Obstructive Ventilatory Impairment | Restructive Ventilatory Impairment | Combined Ventilatory Impairment | Bonferroni post hoc test |
|---|---|---|---|---|---|
| Grip strength (kg) | 18.8±4.1 | 18.6±3.7 | 16.6±3.8 | 16.4±4.8 | NVC vs RVI**<br>NVC vs CVI*<br>OVI vs RVI** |
| Knee joint extension strength (newton•meter/kg) | 1.2±0.3 | 1.1±0.3 | 1.0±0.3 | 1.0±0.4 | NVC vs RVI** |
| Comfortable gait velocity (meter/second) | 1.3±0.2 | 1.3±0.2 | 1.1±0.2 | 1.0±0.2 | NVC vs RVI**<br>NVC vs CVI**<br>OVI vs RVI**<br>OVI vs CVI** |
| Maximal gait velocity (meter/second) | 1.6±0.3 | 1.6±0.3 | 1.4±0.3 | 1.4±0.4 | NVC vs RVI**<br>NVC vs CVI*<br>OVI vs RVI**<br>OVI vs CVI** |
| Timed up-and-go (second) | 9.9±3.1 | 9.9±2.6 | 11.2±4.1 | 12.1±4.8 | NVC vs RVI**<br>NVC vs CVI**<br>OVI vs RVI*<br>OVI vs CVI* |
| Maximal Timed up-and-go (second) | 7.2±1.8 | 7.1±1.4 | 8.0±1.8 | 8.5±3.0 | NVC vs RVI**<br>NVC vs CVI**<br>OVI vs RVI**<br>OVI vs CVI** |
| One leg standing time with eyes open (second) | 26.8±21.7 | 28.8±23.2 | 21.3±19.8 | 21.2±23.9 | NVC vs RVI* |

Obstructive Ventilatory Impairment: %FEV 1.0≤70%
Restructive Ventilatory Impairment: %VC≤80%
Combined Ventilatory Impairment: %FEV 1.0≤70% and %VC≤80%

mean±standard deviation
*: $p<0.05$
**: $p<0.01$

it has been reported that chronic obstructive pulmonary disease, which requires treatment by spirometry, occurs at a considerably high frequency in middle and old-aged residents of Japan[32]. Consequently, the use of spirometry for the elderly population has been promoted; however, the actual optimal state of pulmonary function in the elderly and relationships between pulmonary function and physical function and mobility remain unclear.

Many studies have reported that pulmonary function declines with increasing age, and the rate of decline is accelerated among those of advanced aged[23]. However, Pfitzenmeyer et al. found that individuals in the advanced age population who demonstrated good pulmonary function were stronger and generally survived for a longer time[24]. Our results, like many other studies, indicate that advanced age as well as diminished physical function and mobility are associated with inferior (declining) pulmonary function.

Pulmonary function is related to exercise tolerance[33] and nutritional status[34,35]. However, we do not agree with the opinion that a relationship exists between pulmonary function and mobility[36,37]. Our results did not demonstrate a clear relationship between pulmonary function and mobility. According to Kazuhide et al., even if pulmonary function deteriorates in the elderly, it does not have an immediate influence on mobility[38]. Further, Carlos et al. reported that pulmonary function could predict the possibility of future health problems and possibly death[39]. A restrictive ventilatory disorder is dependent on thoracic flexibility that is associated with ventilatory and respiratory muscular strength, both of which are susceptible to aging; it is believed that this influences mobility at some point in the future. The results of our study suggest that diminished pulmonary function is related to the physical function that support mobility. As for clinical implications, our results offer significant value for promoting preventive care. However, the group afflicted with OVI was not different from the group with NVC. For this reason, we believe that 65% of those with mild disease severity have RVI[40].

An age-stratified study model must be used to clarify whether diminished pulmonary function influences mobility. In addition, males should also be included because the rates of decline of pulmonary function and physical function show sex differences. We can also prevent the decline of pulmonary function by certain specific interventions; however, we must clarify whether these measures would improve or maintain mobility. In this way, we may be able to contribute to a reduction in medical costs and improvements in the quality of life of the elderly.

## ACKNOWLEDGMENTS

We thank the staff who helped conduct the study and also the women who extended their cooperation to our group. Special thanks to Dr Kim, Dr Hirano, Dr Yoshida and Dr Saito, who gave their generous support. I also thank my family who gave me the time to undertake this study.

## REFERENCES

1) Ministry of Public Management, Home Affairs: Posts and Telecommunications Statistics Bureau homepage: http://www.stat.go.jp/data/jinsui/index.htm. (Accessed Nov. 1, 2010).

2) Suzuki T: Comprehensive mass health examination system for the community elderly – A new strategy for increase of physical fitness and for prevention of long-term care status. The Journal of Japan Academy of Health Sciences, 2004, 3: 133–138.

3) Kim HS, Tanaka K: The assessment of functional age using "Activities of Daily Living" performance tests. A study of Korean women. Journal of the American Psychoanalytic Association, 1995, 3: 39–53.

4) Nagasaki H, Itoh H, Furuna T, et al.: The structure underlying physical performance measures for older adults in the community. Aging Clinical and Experimental Research, 1995, 7: 451–458.

5) Kinugasa T, Nagasaki H, Furuna T, et al.: Physical performance measurement for characterizing high function older persons. Journal of Aging and Physical Activity, 1996, 4: 338–348.

6) Furuna T, Nagasaki H, Nishizawa S, et al.: Longitudinal change in the physical performance of older adults in the community. Journal of the Japanese Physical Therapy Association , 1998, 1: 1–5.

7) Daubney ME, Culham EG: Lower extremity muscle force and balance performance in adults aged 65 years and older. Phys Ther, 1999, 79: 1177–1185.

8) Suzuki T, Yoshida H, Kim H, et al.: Walking speed as a good indicator for maintenance of I-ADL among the rural community elderly in Japan. Geriatric Gerontology International, 2003, 3: 6–14.

9) Yoshida H, Suzuki T, Kim H, et al.: Effects of osteoporotic fractures on quality of life-related variables in the community elderly in Japan; an 8-year follow-up study in TMIG-LISA. Geriatric Gerontology International, 2003, 3: 50–54.

10) Janssens JP, Pache JC, Nicod LP, et al.: Physiological changes in respiratory function associated with aging. Eur Respir J, 1999, 13: 197–205.

11) Meyer KC: Aging. Proceedings of the American Thoracic Society, 2009, 2: 433–439.

12) Nishizawa T: The change of the lungs function. Circular Breathing, 2002, 50: 665–668.

13) Klock RA: Influence of aging on the lung. New York: Van Nostrand Reinhold, 1977, pp432–444.

14) Chan ED, Welsh CH: Geriatric respiratory medicine. Chest, 1998, 114: 1704–1733.

15) Turner JM, Mead J, Wohl ME: Elasticity of human lungs in relation to age. J Appl Physiol, 1968, 25: 664–671.

16) Crapo RO, Morris AH, Clayton PD, et al.: Lung volumes in healthy nonsmoking adults. Bulletin of European Physiopathology and Respiration, 1982, 18: 419–425.

17) Knudson RJ: Aging of the respiratory system. Current Pulmonology, 1989, 10: 1–24.

18) Anthonisen NR, Danson J, Robertson PC, et al.: Airway closure as a function of age. Respir Physiol, 1970, 8: 58–65.

19) Chen HI, Kuo CS: Relationship between respiratory muscle function and age, sex, and other factors. J Appl Physiol, 1989, 66: 943–948.

20) Enright PL, Knormal RA, Manolio TA, et al.: Respiratory muscle strength in the elderly: correlates and reference values. Am J Respir Crit Care Med, 1994, 149: 430–438.

21) Suzuki M, Teramoto N: An aging change of the maximum expiratory muscular strength and the maximum inspiratory muscular strength. Japanese Journal of Thoracic Diseases, 1997, 35: 1305–1311.

22) Burrows B, Cline MG, Kundson MJ, et al.: A descriptive analysis of the growth and decline of the FVC and FEV1.0. Chest, 1983, 83: 717–724.

23) Camili AE, Burrows B, Kundson MJ, et al.: Longitudinal changes in forced expiratory volume in 1 second in adult: methodological considerations and findings in healthy nonsmokers. Am Rev Respir Dis, 1986, 133: 974–980.

24) Pfitzenmeyer P, Laurent B, Philippe D, et al.: Lung function in advanced age: Study of ambulatory subjects aged over 75 years. Gerontology, 1993, 39: 267–275.

25) Senzyu H: The chest rehabilitation of the pulmonary emphysema. Kyoto: Kinboudou, 1998, pp131–141.

26) The Japanese Respiratory Society: The Pulmonary Function Test Guidelines, Tokyo: Medical View 2004.

27) Podsiadlo D, Richardson S: The Timed "Up & Go": a test of basic functional mobility for frail elderly persons. J Am Geriatr Soc, 1991, 39: 142–148.

28) Baker PS, Bodner EV, Allman RM: Measuring life-space mobility in community-dwelling older adults. J Am Geriatr Soc, 2003, 51: 1610–1614.

29) Abe T, Hashidate H, Shimada H, et al.: The association of activity assessed by Life-Space Assessment with physical function and instrumental activities of daily living in elderly people. Rigakuryoho Kagaku, 2009, 24: 721–726.

30) Koyano W, Shibata H, Nakazato K, et al.: Measurement of competence:

reliability and validity of the TMIG Index of Competence. Archives of Gerontology and Geriatrics1991, 13: 103–116.
31) Ministry of Education, Culture, Sports, Science and Technology: Physical functions investigation in 2008: http://www.mext.go.jp/b_menu/toukei/001/index22.htm (Accessed Dec. 10, 2010).
32) Fukuchi Y, Nishimura M, Ichinose M, et al.: COPD in Japan: Nippon COPD Epidemiology study. Respirology, 2004, 9: 458–465.
33) Senzyu Y, Ouike T, Kurita K, et al.: About breathing muscular strength and the lungs function of the CPOD patient, relevance with the exercise tolerance. Nagasaki University Medical Department Bulletin, 2002, 15: 9–14 (in Japanese).
34) Tashiro T, Urata H, Senzyu H, et al: Breathing muscular strength and the lower limbs muscular strength of the COPD patient, a study about the nourishment state. Nagasaki University Medical Department Bulletin, 2002, 15: 1–8 (in Japanese).
35) Morimoto M, Takai K: The relationship between functional impairments and activities of patients with chronic obstructive pulmonary disease. Journal of the Japanese Academy of Nursing Science, 2004, 24: 13–20 (in Japanese).
36) Prigatano P, Wright E, Levin D, et al.: Quality of life and its predictors in patients with mild hypoxemia and Chronic Obstructive Pulmonary Disease. Archives of Internal Medicine, 1984, 144: 1613–1619.
37) Jones P, Baveystock C, Littlejohns P: Relationships between general health measured with the sickness impact profile and respiratory symptoms, physiological measures, and mood in patients with chronic airflow limitation. American Review of Respiratory Disease, 1989, 140: 1538–1543.
38) Tomita K, Okazaki D, Akai Y, et al.: Actual conditions survey of respiratory muscle weakness in community dwelling elderly people – A preliminary cross-sectional study in Gunma mountain area. Physiotherapy Gunma, 2008, 19: 13–19 (in Japanese).
39) Carlos A, Evelyne A, Peter H, et al.: Peak Expiratory Flow as a Predictor of Subsequent Disability and Death in Community-Living Older Persons. J Am Geriatr Soc, 2008, 56: 1014–1020.
40) Pauwels R, Buist A, Ma P, et al.: Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease: National Heart, Lung, and Blood Institute and World Health Organization Global Initiative for Chronic Obstructive Lung Disease (GOLD): executive summary. Respiratory Care, 2001, 46: 798–825.

卒後研修会講演

# 転倒予防のエビデンス

島田 裕之[1], 大矢 敏久[2], 阿南 祐也[1]

## はじめに

高齢者が転倒する原因はさまざまであるが，大きく要因を分けると①身体的要因，②環境要因，③活動要因の３つに分類できる（図１）．身体的要因は，筋力低下，バランス・歩行機能低下といった身体機能低下による要因と，知的機能低下が含まれる．環境要因には，段差や手すりがないなどの物理的要因と，介護者不足といった人的要因が挙げられる．さらに，施設への短期入所などで環境が急激に変化することも転倒を誘発する．活動要因とは，転倒の直接的な原因となるすべての活動を指し，とくに自分の身体機能に見合った行動をとらない場合がもっとも危険といえる．また，活動時の安全性はその行動をとる前後の状況に修飾される．具体的には，急いでいる状況では安全確認が不十分となり，転倒する危険性の上昇が予想される．このように転倒の要因は多彩であり，転倒を予防するためには身体・環境・活動の３要因を含んだ包括的な評価が必要となる[1]．

転倒の危険因子の影響度を調べた研究では，最も危険性の高い要因は知的機能の低下と向精神薬の服用であり，視覚機能低下，バランス障害，下肢筋力の低下，ADL障害，歩行補助具の使用も危険度が高い要因とされている[2]（表１）．高齢者の転倒を予測，または予防するための方法を考える際には，これらの要因を注意深く観察する必要がある．また，身体的要因に着目した研究によると，筋力低下により転倒の危険性が約５倍上昇し，バランス障害や歩行障害で約３倍上昇するとされ，これらが転倒に影響を及ぼす身体機能の主要因であると考えられる[3]（図２）．

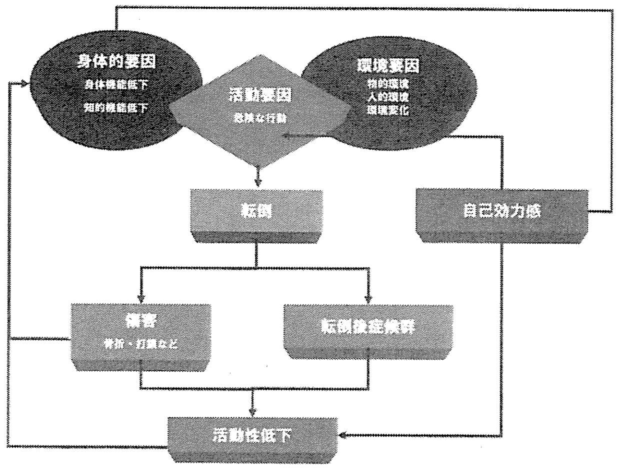


図１　転倒発生の要因と悪循環の形成過程

転倒の危険因子である身体的要因を有する者が転倒の危険性の高い環境で活動することにより転倒が生じる．傷害や転倒後症候群から機能低下や活動量が減少し，身体的要因をさらに増悪させ，転倒の危険が上昇するといった悪循環を形成する．

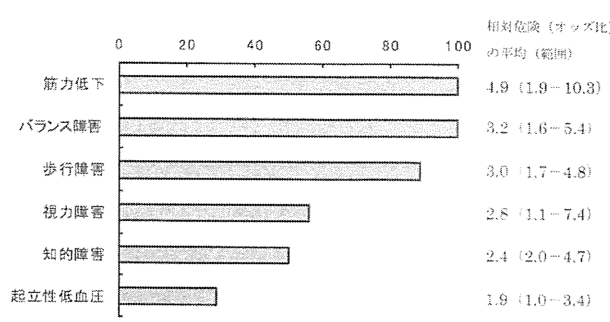


図２　身体的要因に着目した転倒の危険因子

16の転倒の危険因子に関する研究をまとめた結果．図は有意な転倒の危険因子として認めた研究の割合を示した．危険度は，各危険因子を有する者がそうでない者に対して転倒の危険が何倍かを示した．

1）国立長寿医療研究センター 認知症先進医療開発センター 在宅医療・自立支援システム開発部 自立支援システム開発室
（〒474-8511 愛知県大府市森岡町源吾35）
Hiroyuki Shimada, Yuya Anan：Section for Health Promotion, Department of Health and Medical Care, Center for Development of Advanced Medicine of Dementia, National Center for Geriatrics and Gerontology
2）名古屋大学大学院医学系研究科リハビリテーション療法学専攻
Toshihisa Oya：Program in Physical and Occupational Therapy, Graduate School of Medicine, Nagoya University

表１　転倒の危険因子とその影響度

| 危　険　因　子 | 地域在住高齢者 | 施設入所高齢者 |
|---|---|---|
| 知的機能低下 | 1 | 2 |
| 向精神薬の服用 | 1 | 2 |
| 視覚機能低下 | 2 | 2 |
| バランス障害 | 2 | 2 |
| 下肢筋力の低下・障害 | 2 | 2 |
| 移動・ADL・IADLの低下 | 2 | 2 |
| 歩行補助具の使用 | 2 | 2 |
| 末梢神経筋機能の低下 | 2 | 6 |
| 中等度の活動状態（予防的効果） | 2 | |
| 多剤利用 | 2 | 3 |
| 障害物 | 2 | |
| 飲酒（予防的効果） | 2 | |
| 尿失禁 | 3 | 2 |
| 起立性・食後の低血圧 | 3 | 2 |
| めまい | 3 | 2 |
| 高い活動状態 | 3 | |
| 心臓病薬の服用 | 3 | 2 |
| 握力低下・上肢機能障害 | 4 | 3 |
| 下肢協調動作障害 | 4 | 3 |
| 歩行異常 | 4 | 2 |
| 活動制限・低い活動状態 | 4 | 2 |
| 社会的ネットワークの低下 | 4 | 6 |
| うつ病 | 5 | 2 |
| 聴力障害 | 6 | 2 |
| 抗炎症薬の服用 | 6 | |
| 鎮痛剤 | | 2 |
| 抑制具の使用 | | 2 |

Moreland J, et al: Evidence-based guidelines for the secondary prevention of falls in older adults. Gerontology 2003; 49: 93-116.より一部改変して作表
1がもっとも危険度が高い要因で6がもっとも低い要因である

高齢者における虚弱や転倒による傷害を減少させるための運動介入の効果を調べた研究ではFrailty and Injuries：Cooperative Studies of Intervention Techniques（FICSIT trial）が有名である．この研究プロジェクトは米国の８つの地域において異なる運動介入方法で無作為化比較対照試験を行った大規模なプロジェクト研究である[4-11]．これらの結果をまとめた報告[12]では，運動以外の介入効果も加味した場合には，筋力増強練習やバランス練習などを含んだ複合的な運動介入，およびバランス練習を行った者において転倒予防効果が認められたとしている．しかし，運動以外の介入効果を除外して，運動による効果のみを抽出すると，バランス練習のみにおいて転倒予防効果が認められている．このバランス練習には，太極拳のようなゆっくりとした動きを用いた動的なバランス練習や，コンピューターを用いたフィードバック練習が取り入れられていた．これらの介入の中で太極拳を施行した群において，最も高い転倒予防効果が認められている（表２）．このプロジェクト研究の成功によって，太極拳などの運動を用いた転倒予防のための取り組みが盛んに行われるようになった．我が国においても転倒予防のための取り組みは，介護予防事業のなかの転倒予防教室（寝たきり防止事業）として広く行われ，2003年には全国で約６割の自治体が事業化している[13]．転倒予防教室では，運動プログラムをはじめ，教育講演，家屋調整，服薬相談などが行われるが，中核となるのは運動プログラムである場合が多い．

本稿では，高齢者の転倒予防に対する多面的介入の効果を紹介し，中でも身体機能からみた転倒の主要な危険因子である筋力低下，バランス，歩行障害に対して，現在まで行われてきた運動プログラムの方法と効果について焦点を当てて概観する．また，転倒予防に対する取り組みの資料として活用できるように，運動介入を行う際の原則についても紹介する．

表２　FICSIT研究における運動介入の効果

| | 推定に用いた研究数 | プールされた推定値 | P値 |
|---|---|---|---|
| すべての介入手段を含んだ推定 | | | |
| エクササイズ | 13 | .90 | .04 |
| 筋力トレーニング | 8 | .96 | .59 |
| バランス練習 | 6 | .83 | .03 |
| 持久力練習 | 3 | .98 | .87 |
| 柔軟体操 | 6 | .93 | .29 |
| トレーニング以外の介入手段を除いた推定 | | | |
| エクササイズ | 10 | .87 | .12 |
| 筋力トレーニング | 6 | .99 | .94 |
| バランス練習 | 4 | .75 | .01 |
| 持久力練習 | 2 | 1.14 | .62 |
| 柔軟体操 | 3 | 1.08 | .63 |

Province MA, Hadley EC, et al.：The effects of exercise on falls in elderly patients：A preplanned meta−analysis of the FICSIT trials. JAMA 1995；273：1341−1347. より作表

## 転倒予防のための多面的介入の効果と運動介入の位置づけ

### 1）コクラン・システマティックレビューの結果

高齢者の転倒予防のための介入手段に関するコクラン・システマティックレビューによると，①筋力強化やバランストレーニング，太極拳，専門家によって処方された家庭内トレーニングといった運動プログラム，②家屋調整，③向精神薬の見直し，④前述の複合プログラムにおいて転倒予防効果があるとされている[14]（表3）．運動プログラムでは転倒率のみでなく，傷害を来たす転倒の発生を抑制する効果も認められている．

表3　コクラン・システマティックレビューの結果

| 介入方法 | 対象の属性 | 研究数（対象数） | 相対危険（95%CI） |
|---|---|---|---|
| 運動（筋力強化，バランス，歩行トレーニング） | 地域在住高齢者 | 3（566） | 0.80（0.66−0.98） |
| 家屋調整 | 地域在住高齢者（選別なし） | 3（1163） | 0.85（0.74−0.96） |
| 向精神薬の見直し | 地域在住高齢者 | 1（93） | 0.34（0.16−0.74） |
| 複合的介入（評価,運動,環境調整） | 地域在住高齢者（選別なし） | 4（1651） | 0.73（0.63−0.85） |
| | 地域在住高齢者（転倒の既往や転倒のリスクを持つ者） | 5（1176） | 0.86（0.76−0.98） |
| | 施設入所高齢者 | 1（439） | 0.60（0.50−0.73） |

Gillespie LD, Gillespie WJ, Robertson MC, et al.：Interventions for preventing falls in elderly people. Cochrane Database Syst Rev 2003；(4)：CD000340.より作表

### 2）運動・視力補正・家屋調整の転倒予防効果に関する研究

この研究は，オーストラリアで実施された大規模介入研究である[15]．対象は都市部の在宅居住の70歳以上の高齢者1090名であり，これらの高齢者を無作為に運動実施群，視力補正群，家屋調整群の組み合わせで8群を形成して介入を実施した．18か月の転倒調査の結果，介入を実施しなかった対照群と比較し運動を介入に取り入れた群において転倒予防効果が認められ，視力補正や家屋調整のみでは効果的な転倒予防介入とならなかった．もっとも高い効果を示したのは，3種類すべての介入を行った群であり，介入しなかった群と比較して転倒の危険が0.67に減少した（表4）．この研究で実施した運動は15週間，週1回，1回60分間のグループ練習と家庭での自主練習であった．運動の内容は柔軟体操，下肢筋力強化，バランストレーニングであり，バランストレーニングに重点をおいて計画されたプログラムであった．この研究によって，包括的な転倒予防の中での運動プログラムの位置づけが明確となり，運動プログラムを適用することの重要性が明らかとなった．

表4　介入による転倒予防効果

| 介入方法 | 転倒者数 人数（%） | 危険率比 推定値（95%CI） | P値 | NNT* |
|---|---|---|---|---|
| 介入しない | 87／137（63.5） | 比較対照（1.00） | | |
| 運動 | 76／135（56.3） | 0.82（0.70−0.97） | 0.02 | 14 |
| 視力補正 | 84／139（60.4） | 0.89（0.75−1.04） | 0.13 | 23 |
| 家屋調整 | 78／136（57.4） | 0.92（0.78−1.08） | 0.29 | 32 |
| 運動＋視力補正 | 66／136（48.5） | 0.73（0.58−0.91） | 0.01 | 9 |
| 運動＋家屋調整 | 72／135（53.3） | 0.76（0.60−0.95） | 0.02 | 10 |
| 視力補正＋家屋調整 | 78／137（56.9） | 0.81（0.65−1.02） | 0.07 | 14 |
| 運動＋視力補正＋家屋調整 | 65／135（48.1） | 0.67（0.51−0.88） | 0.004 | 7 |

*1回の転倒を防ぐため，介入に必要とされる対象者数
Day L, Fildes B, Gordon I, et al.：Randomised factorial trial of falls prevention among older people living in their own homes. BMJ 2002；Jul 20；325（7356）：128−131.より一部改変して作表

## 運動トレーニングの効果

高齢者の転倒予防のために実施された運動トレーニングの中から，とくに転倒の危険因子である筋力，バランス，歩行に関するトレーニングの方法と効果について概観する．

### 1）高齢者に対する筋力トレーニングの効果

筋力強化トレーニングを高齢者に対し処方すると，多くの研究で筋力の増強が認められる[16-27]．筋力トレーニングの方法は，マシンを用いて高負荷で行う場合と，自重や重錘などを用いて中～低強度で行う場合とがある．また，実施頻度や介入期間，対象者によって筋力向上の程度は異なるが，概ね10～60%の向上が期待できる[16-21]．1回の反復運動が可能な最大荷重量（1 repetition maximum：1RM）を漸増的に80%まで増強させる高負荷で練

習を行った場合，約20～65％の高い増強効果が認められている．ただし，虚弱高齢者に急激な高負荷筋力強化は危険を伴うため，最初は自重を用いた練習や，1RMの20－30％程度の低負荷トレーニングから開始することが望ましい．自重やセラバンドを使用した家庭での低強度の筋力強化でも5～25％前後の筋力の向上が認められ，高負荷トレーニングと比較すると上昇率は落ちるものの，運動の効果が確認されている[17-23]．高強度の下肢筋力強化による転倒予防効果を調べたBuchnerらは，地域在住高齢者を対象として，下肢筋力強化（1RMの50～75％）と自転車エルゴメーター（75％心拍数予備）による運動介入を24～26週間，週に3回，1回につき60分間行い対照群と比較した結果，初回転倒までの相対ハザード比は，0.53（95％信頼区間：0.30－0.91）に減少したとしている[26]．

わが国では平成15年度から介護予防事業の新規メニューとして，高齢者筋力向上トレーニング事業が追加された．この事業は高齢者用の筋力トレーニングマシンを用いて筋力増強を図り，要介護状態に陥ることを予防する目的で実施されるが，筋力の向上によって転倒予防効果も得られ，意義の高い事業であると考えられる．

### 2）バランス・歩行練習の効果

高齢者に運動処方する場合は，通常は筋力トレーニング，バランス練習，有酸素運動などを複合することが多いため，バランスや歩行練習に限定して効果を検討した研究は少ない．しかし，各練習の効果を分類して検証した研究をみると，その多くが有効性を認めている．

Huらは地域在住高齢者に対してフォームを用いた立位バランス練習を実施した結果，片足立ち時間や動的バランス，姿勢バランス反応の改善が認められたとしている[27, 28]．Wolfsonらは，姿勢バランス練習群と筋力増強群に健常高齢者を分類し実験を行い，姿勢バランス練習群ではSensory Organization Testや随意的重心移動能力といった姿勢バランスの向上が認められ，筋力増強群では下肢筋力が向上したと報告している[29]．Wolfらは，地域在住高齢者を対象に重心動揺計を用いた立位バランス練習を行う群と，太極拳を行う群との運動介入効果を検討した結果，前者は重心動揺，後者は転倒への恐怖感が改善したと報告している[30]．また，Gauchardらは，ヨガを応用したバランス練習を行う群と，水泳やサイクリングといった有酸素運動を行う群に健常高齢者を分類し，運動介入を行った結果，バランス練習群では動的バランス機能の改善が認められ，有酸素運動群では下肢筋力が向上したとしている[31]．Shimadaらは，施設を利用する機能維持期高齢者をバランス練習と歩行練習の群に分類して運動介入を行い，バランス練習を行った群では静的バランス機能の改善が認められ，歩行練習を行った群では動的バランス機能および歩行機能の改善が認められたとしている[32]．これらの研究から，高齢者に対するバランス練習や歩行練習は身体機能の改善に効果的であり，実施する運動内容と改善する機能が対応関係にあることが分かる．そのため，運動処方をする際には，対象者の機能状態を評価し，低下した機能に対する運動介入を実施することで，効果的かつ効率的な取組みが可能になると考えられる．

また，転倒予防に対する効果に関しては，先に紹介したFICSIT trialのアトランタグループの研究が代表的であろう．この研究は，地域在住高齢者200名を対象に，太極拳，バイオフィードバックを用いたバランストレーニング，健康教育（対照群）を行う3群で転倒予防効果を調べた．介入期間は15週間であり，頻度は太極拳が週2回，バランスと健康教育は週1回実施し，太極拳については1日に2回少なくとも15分間の練習を行うように指導した．介入後4か月間の転倒調査から，太極拳を行った群に転倒予防効果が認められた（リスク比：0.53，95％信頼区間：0.32－0.86）[33]．この研究では家庭における運動の実施率についての記述はないが，家でひとりでもできる運動課題を高齢者が持って，運動習慣を身につけることが重要であると考えられる．

## 高齢者に対して運動介入を行う際の原則

高齢者への運動介入を円滑に進めるための前提となる留意点を述べる．

### 1）エイジズムの排除と目標の設定

高齢者は自己の身体機能の改善に対して「あきらめ」ている者が少なくない．また，高齢者を取り巻く周囲の見方も「年なのだから無理しないように」といったように，運動に対して積極的では

ないことがある．これは身体機能の改善に対する目標が明確化されていないときに生じやすい．表5に身体機能に関する生理的な加齢変化と廃用による機能低下，および運動の効果を示した[15]．高齢者の身体機能の低下は加齢変化と廃用とが混在しているため，少なくとも廃用に関しては運動介入によって改善可能であることを認識する必要がある．さらに，廃用症候群の予防に焦点を絞った目標を設定することで，指導者と対象である高齢者のエイジズムは排除され，具体的な行動目標を立てて共通の認識の下に運動介入を実施することが可能となる．

表5：身体の生理学的変化と加齢，活動性，運動との関係

| 身体機能 | 加齢変化 | 廃用 | 運動の実施 |
|---|---|---|---|
| 呼吸循環機能 | | | |
| $VO_2max$ | ↓ | ↓ | ↑ |
| 最大心拍数 | ↓ | ←→ | ←→ |
| 最大心拍出量 | ↓ | ↓ | ↑ |
| 1回心拍出量 | ↓ | ↓ | ↑ |
| 筋機能 | | | ↑ |
| 筋力 | ↓ | ↓ | ↑ |
| 筋繊維数 | ↓ | ↓ | ↑ |
| 筋容量 | ↓ | ←→ | ←→ |
| 神経機能 | | | |
| 神経伝達速度 | ↓ | ←→ | ←→ |

Pu CT, Nelson ME: Aging, function, and exercise. In Frontera WR, Dawson DM, Slivik DM edt. Exercise in rehabilitation medicine. Human Kinetics, Champaign, 1999, pp391-424. より作表

### 2）運動処方の原則

高齢者に対して運動を安全かつ効果的に行うためには，①運動の開始時は負荷の小さなものから開始して，漸増量も少なくする，②理解が得られ易い簡単な運動から開始する，③運動時の転倒事故を予防するために，手すりの使用や監視を強化する，④運動強度の誤認を予防するため，心拍数に影響を与える薬剤の使用を確認することが重要である．

また，高齢者は多様な疾病や障害を有している場合が多く，運動の実施に際してはリスク管理が重要となる．とくに重篤な心疾患を有する者では細心の注意が必要であり，運動負荷試験を事前に行うことが望ましい．また，多くの高齢者が高血圧，動脈硬化を有しており，運動中の血圧上昇によって血管障害を引き起こす可能性があるため，運動時の血圧測定は重要である．血圧は変動が大きいため，一度みておけばよいというものではなく，毎回の運動時に定期的な測定が必要である．また，血圧の測定時に服薬の確認も行い，服薬の徹底を促すとよい．

### 3）モチベーションの向上

高齢者は自己の身体機能の改善に対して否定的な者が少なくない．特に慢性の疾病や障害を有する者では，「いまさら運動などしてもよくなるはずがない」といった否定的な見解を持つ者が多い．さらに，社会における自分の役割を見出すことができない，あるいはやりたいことが見つからない場合には，運動して自己の状態を改善することへの目的意識が持てないため，行動に結びつかない．このような問題を抱えた高齢者に運動処方する場合には，運動の効果を説明し，説得することから始めなければならない．その際の前提条件として，指導者と対象者間の信頼関係が築かれている必要がある．信頼関係の構築のためには，肩書き，所属，専門的知識，言葉づかい，身だしなみなど様々な要素が影響するが，とくに言葉づかいに関しては，意識的に状況に応じて使い分けながら信頼を獲得するよう努める必要がある．

### 4）運動習慣の獲得

身体機能を持続するためには運動を習慣化する必要があるが，そのためには運動に対するモチベーションを高め，運動の必要性を認識する必要がある．そして実際に運動を開始するためには，運動方法を知り，運動場所や運動器具などの周辺環境の整備も重要である．そして運動の継続には，仲間作りや他人からの励まし，運動効果の実感などの心理的な要因が大きく作用する[16]．高齢者に対して運動介入を実施していくときには，単に運動することに留まるのではなく，身体に関する情報を提供して運動方法の理解を促すことや，運動に適した環境を整備すること，そして仲間作りを促進して，目的を共有できるグループを形成するなどの支援をする必要がある．

## おわりに

ここでは高齢者の転倒予防に対する介入の中でも運動介入に焦点を当て，その方法と効果につい

て概観した．転倒予防のカギとなるのは筋力トレーニング，バランスや歩行トレーニングであり，これらを複合したプログラムを作成して，自宅で自主トレーニングできるよう支援することが転倒予防の運動介入としてエビデンスの高い対処法であると考えられる．

## 参考文献


1）島田裕之：介護老人保健施設の理学療法：長期ケア施設における機能評価と転倒予防の方法．理学療法科学 17：141－148, 2002

2）Moreland J, et al：Evidence-based guidelines for the secondary prevention of falls in older adults. Gerontology 49：93－116, 2003

3）Rubenstein LZ, Josephson KR：Interventions to reduce the multifactorial risks for falling. Masdeu JC, Sudarsky L, Wolfson L（edt）：Gait disorders of aging：falls and therapeutic strategies, Lippincott Raven. pp 309－326, 1997.

4）Hornbrook MC, Stevens VJ, Wingfield DJ：Seniors' Program for Injury Control and Education. J Am Geriatr Soc. Mar 41(3)：309－314, 1993

5）Tinetti ME, Baker DI, Garrett PA, et al.：Yale FICSIT：risk factor abatement strategy for fall prevention. J Am Geriatr Soc. Mar 41(3)：315－320, 1993

6）Buchner DM, Cress ME, Wagner EH, et al.：The Seattle FICSIT/MoveIt study：the effect of exercise on gait and balance in older adults. J Am Geriatr Soc. Mar 41(3)：321－325, 1993

7）Mulrow CD, Gerety MB, Kanten D, et al.：Effects of physical therapy on functional status of nursing home residents. J Am Geriatr Soc. Mar 41(3)：326－328, 1993

8）Wolf SL, Kutner NG, Green RC, et al.：The Atlanta FICSIT study：two exercise interventions to reduce frailty in elders. J Am Geriatr Soc. Mar 41(3)：329－332, 1993

9）Fiatarone MA, O' Neill EF, Doyle N, et al.：The Boston FICSIT study：the effects of resistance training and nutritional supplementation on physical frailty in the oldest old. J Am Geriatr Soc. Mar 41(3)：333－337, 1993

10）Wallace RB, Ross JE, Huston JC, et al.：Iowa FICSIT trial：the feasibility of elderly wearing a hip joint protective garment to reduce hip fractures. J Am Geriatr Soc. Mar 41(3)：338－341, 1993

11）Wolfson L, Whipple R, Judge J, et al.：Training balance and strength in the elderly to improve function. J Am Geriatr Soc. Mar 41(3)：341－343, 1993

12）Province MA, Hadley EC, et al.：The effects of exercise on falls in elderly patients：A preplanned meta-analysis of the FICSIT trials. JAMA 273：1341－1347, 1995

13）厚生労働省老健局：介護予防について．老年精神医学雑誌 15：9－14, 2004

14）Gillespie LD, Gillespie WJ, Robertson MC, et al.：Interventions for preventing falls in elderly people. Cochrane Database Syst Rev(4)：CD000340, 2003

15）Day L, Fildes B, Gordon I, et al.：Randomised factorial trial of falls prevention among older people living in their own homes. BMJ. Jul 20；325（7356）：128－131, 2002

16）Pu CT, Nelson ME：Aging, function, and exercise. Frontera WR, Dawson DM, Slivik DM（edt.）Exercise in rehabilitation medicine. Human Kinetics, Champaign, pp391－424, 1999

17）山口幸生：身体活動の促進．ライフスタイル療法－生活習慣改善のための行動療法　足達淑子（編），医歯薬出版．pp64－70, 2001.

18）Fiatarone MA, O' Neill EF, et al.：Exercise training and nutritional supplemention for physical frailty in very elderly people. N Eng J Med 330：1769－1775, 1994

19）Nelson ME, Fiatarone MA, et al.：Effects of high-intensity strength training on multiple risk factors for osteoporotic fractures. JAMA 272：1909－1914, 1994

20）McCartney N, Hicks AL, et al.：Long-term resistance training in the elderly：Effects on dynamic strength, exercise capacity, muscle, and bone. J Gerontol 50A：B97－B104, 1995

21）Ades PA, Ballor DL, et al.：Weight training improves walking endurance in healthy elderly persons. Ann Int Med 124：568－572, 1996

22）Hagberg JM, Graves JE, et al.：Cardiovascular responses of 70-to 79-yr-old men and women to exercise training. J Appl Physiol 66：2589－2594, 1989

23）Skelton DA, Young A, et al.：Effects of resistance training on strength, power, and selected functional abilities of women aged 75 and older. J Am Geriatr Soc 43：1081－1087, 1995

24）Chandler JM, Duncn PW, Kochersberger G, et al.：Is lower extremity strength gain associated with improvement in physical performance and disability in frail, community-dwelling elders？ Arch Phys Med Rehabil 79：24－30, 1998

25）Jette AM, Lachman M, Giorgetti M, et al.：Exercise－It's never too late：The strong-for-life program. Am J Public Health 89：66－72, 1999

26）Buchner DM, Cress ME, et al.：The effect of strength and endurance training on gait, balance, fall risk, and health services use in community-living older adults. J Gerontol 52A：M218－M224, 1997

27）Hu MH and Woollacott MH：Multisensory training of standing balance in older adults：Ⅰ. Postural stability and one-leg stance balance. J Gerontol 49：M52－M61, 1994

28）Hu MH and Woollacott MH：Multisensory training of standing balance in older adults：Ⅱ. Kinematic and electromyographic postural responses. J Gerontol 49：M61－M71, 1994

29）Wolfson L, Whipple R, Derby C, et al.：Balance and strength training in older adults：Intervention gains and Tai Chi maintenance. J Am Geriatr Soc 44：498－506, 1996

30）Wolf SL, Barnhart HX, Ellison GL, et al.：The effect of Tai Chi Quan and computerized balance training on postural stability in older subjects. Phys Ther 77：371－381, 1997

31) Gauchard GC, Jeandel C, et al. : Beneficial effect of proprioceptive physical activities on balance control in elderly human subjects. Neuroscience Letters 273 : 81－84, 1999
32) H Shimada, Y Uchiyama and S Kakurai : Specific effects of balance and gait exercises on physical function among the frail elderly. Clin Reha 17(5) : 472－479, 2003
33) Wolf SL, Barnhart HX, Kutner NG, et al : Reducing frailty and falls in older persons : an investigation of Tai Chi and computerized balance training. J Am Geriatr Soc 44 : 489－497, 1996

# 5．筋力と身体活動の評価法

島田 裕之*
しまだ ひろゆき


- サルコペニアを把握するために筋力および身体活動の評価は重要である．
- 筋力の評価には握力が簡便であるが，下肢筋力の測定も併せて行うことが望ましい．
- 身体活動の質問調査として，International physical activity questionnaire や life-space assessment が有用であろう．
- 身体活動の実測調査には，加速度計や global positioning system を用いた計測方法がある．
- 筋力，身体活動ともに，日本人におけるサルコペニアのカットポイントは明らかとなっていない．


Key Words　握力検査，IPAQ，life-space assessment，加速度計測，GPS

## □ 筋力の加齢変化

筋力は通常20〜30歳代にピークを迎え，その後は徐々に低下を示す．620名の高齢者を対象として4年間の縦断調査を行った研究では，握力の変化は男性で12%，女性は19%とされ，高齢期には年間3〜5%程度の筋力の低下が認められる[1)]．また，この筋力の低下は上肢より下肢に強く現れる．筋力の低下とともに，筋力を素早く発揮する筋パワーも加齢に伴い低下する．これは，加齢に伴い筋萎縮が生じるのみでなく，タイプII線維の減少による高速度のミオシン重鎖蛋白の減少によるものである．筋パワーの低下は，歩行や階段昇降などの日常生活動作能力と関連し，転倒回避能力の低下にもつながることから，高齢期において保持すべき筋機能であると考えられる．

## □ 筋力測定における留意点

筋の収縮様式には，関節運動を伴わない等尺性収縮と，筋が短縮しながら収縮する求心性収縮と，伸長しながら収縮する遠心性収縮とに分けられる．また，日常生活では生じ得ないが，角速度が一定の関節運動を等速性収縮と呼んでいる．筋力測定では，これらの収縮様式に応じて発揮できる最大筋力を測定することが望ましいが，関節運動を伴う筋力の測定には大掛かりな測定機器を用意する必要があり，実施困難であることが多い．また，高齢者では筋力測定に慣れるまでに時間がかかり，最大筋力を発揮しにくい特徴を持つ．信頼性のある値を取得するために，若年成人と比較して，高齢者では2倍の練習が必要であるとした報告もあり[2)]，筋力測定値を解釈するときに注意が必要である．

## □ 握力検査

筋力測定の実現可能性を高めるためには，小型で安価な測定機器を用いて，簡便に測定可能な方法を採用する必要がある．代表的な筋力測定は握力検査であり，安価な握力計を用意すればよく，検査時間は教示の時間を含めても5分以内で測定可能である．このように，握力検査は簡便に測定可能であり，かつ高齢者の上肢の筋力のみならず他の筋群の筋力も反映する指標として用いることができる[3)]．また，握力は高齢者の日常生活機能低下の予測因子として重要な役割を有しており，スクリーニング検査としては最適な検査方法であろう．

高齢者に筋力検査などの運動機能検査を適用する場合には，検査実施時の安全性や実行可能性を考慮する必要がある．握力検査は，現在まで広く行われてきた検査であり，高齢者にとってもなじみがあり，検査に対する不安が少ない利点を持つ．さらに，握力検査は他の運動機能検査と比較して，すでにサルコペニアを有するような機能が低下した高齢者にも実施できる可能性が高いことがわ

*国立長寿医療研究センター 認知症先進医療開発センター 在宅医療・自立支援開発部 自立支援システム開発室

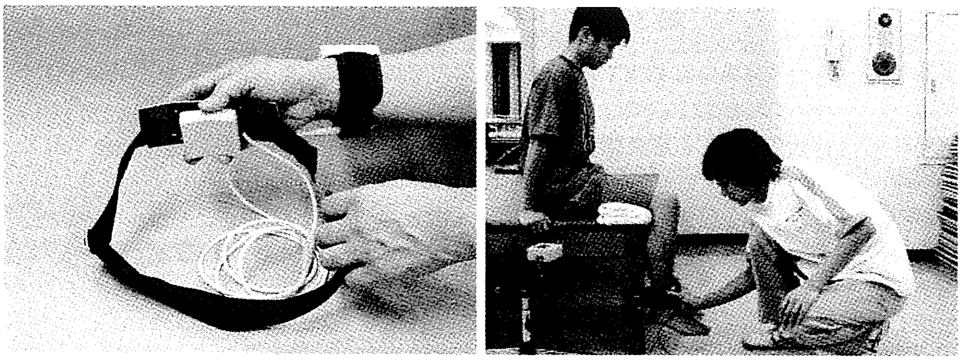

図1　下肢筋力測定器と測定風景

表1　高齢者における握力と膝伸展筋力の基準値

| | | レベル1 | レベル2 | レベル3 | レベル4 | レベル5 |
|---|---|---|---|---|---|---|
| 握力（kg） | 男性 | 25 未満 | 25-28 | 29-32 | 33-36 | 37 以上 |
| | 女性 | 15 未満 | 15-17 | 18-20 | 21-23 | 24 以上 |
| 膝伸展筋力（N） | 男性 | 135 未満 | 135-208 | 209-261 | 262-322 | 323 以上 |
| | 女性 | 81 未満 | 81-140 | 141-176 | 177-215 | 216 以上 |

（鈴木隆雄，大渕修一監修：指導者のための介護予防完全マニュアル：包括的なプラン作成のために．2004 より引用して改変）[5]

かっている[4]．**表1**に高齢者における握力の基準値を示した[5]．

## □ 下肢筋力検査

握力検査は簡便性において高い優位性を持つが，日常生活機能の低下に直接影響する下肢筋力と握力検査値が乖離する例も少なくなく，下肢筋力検査を並行して行うことが望ましい．握力計と比較し，下肢筋力測定器は簡易なものでも高価であるが，定量的な測定をするために用意したい物品の1つである（**図1**）．高齢者における膝伸展筋力の基準値を**表1**に示した（**表1**）．

等尺性膝伸展筋力の測定は，代表的な下肢筋力検査方法であるが，その測定に際しては下肢の関節角度の設定とその位置での固定に注意する必要がある．関節角度が変化すると発揮される筋張力が変化するため，検者は測定中の肢の固定性を注意深く観察しなければならない．

## □ サルコペニアのスクリーニング

近年サルコペニアの国際的な合意形成を目的として the European Geriatric Medicine Society, the European Society for Clinical Nutrition and Metabolism, the International Association of Gerontology and Geriatrics, European Region and the International Association of Nutrition and Aging の4組織が参加した the European Working Group on Sarcopenia in Older People（EWGSOP）によるサルコペニアの操作的定義が発表された．従来の骨格筋量による定義のみでなく，筋力（握力）と歩行速度をサルコペニアの構成要素として含め，サルコペニアと生活機能障害との関係が密接となるように改訂がなされた[6]．サルコペニア判定の握力のカットポイントは，男性で30 kg，女性で20 kg 未満という報告[7]や，虚弱の定義に用いられている握力基準が示されている[8]．しかし，日本人におけるサルコペニア判定の筋力の基準値は明らかとされていない．今後，日本人におけるサルコペニアのカットポイントを筋力の側面から決定していく必要がある．

## □ 身体活動の種類と評価

身体活動の維持や向上は，疾病の予防や寿命の延長に効果的であり，サルコペニアの予防や改善においても中核的な課題である．身体活動には，健康増進のために実施する運動と，日常生活にお