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# Relation between the instrumental activities of daily living and physical fitness tests in elderly women.

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**Abstract**

A cross-sectional study was conducted to quantitatively evaluate the relationship between the instrumental activities of daily living (IADL) and various physical fitness tests in elderly women living at home. The study focused on the total population of those women aged 65 years and over living in Y Town, Hyogo Prefecture, Japan, who visited a nursing home for day services. A total of 128 subjects were divided into two groups: dependent in IADL group (n = 49) and independent in IADL group (n = 79). The magnitude of the relation was evaluated by the odds ratio (OR). The following tests showed a significant decrease in IADL: knee-raising test [age-adjusted OR = 4.23, 95% confidence interval (CI) 1.81-9.87], height (age-adjusted OR = 4.09, 95% CI 1.75-9.56), grip strength (age-adjusted OR = 3.68, 95% CI 1.57-8.60), sit-and-reach test (age-adjusted OR = 2.76, 95% CI 1.20-6.34), and standing on one leg with closed eyes (age-adjusted OR = 2.56, 95% CI 1.09-5.97). Multivariate analysis using Hayashi's quantification method I indicated that knee-raising was the test most highly correlated with decreased IADL. These results suggest that measurement of knee-raising ability, muscle strength of the lower extremities and flexibility of hip joint could be the most useful factors to assess the level of instrumental self-support ability.

**KEYWORDS:** elderly women living at home, instrumental activities of daily living, physical fitness test, kneeraising ability

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# Relation between the Instrumental Activities of Daily Living and Physical Fitness Tests in Elderly Women

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A cross-sectional study was conducted to quantitatively evaluate the relationship between the instrumental activities of daily living (IADL) and various physical fitness tests in elderly women living at home. The study focused on the total population of those women aged 65 years and over living in Y Town, Hyogo Prefecture, Japan, who visited a nursing home for day services. A total of 128 subjects were divided into two groups: dependent in IADL group (n = 49) and independent in IADL group (n = 79). The magnitude of the relation was evaluated by the odds ratio (OR). The following tests showed a significant decrease in IADL: knee-raising test [age-adjusted OR = 4.23, 95% confidence interval (CI) 1.81-9.87], height (age-adjusted OR = 4.09, 95% CI 1.75-9.56), grip strength (age-adjusted OR = 3.68, 95% CI 1.57-8.60), sit-and-reach test (age-adjusted OR = 2.76, 95% CI 1.20-6.34), and standing on one leg with closed eyes (age-adjusted OR = 2.56, 95% CI 1.09-5.97). Multivariate analysis using Hayashi's quantification method I indicated that knee-raising was the test most highly correlated with decreased IADL. These results suggest that measurement of knee-raising ability, muscle strength of the lower extremities and flexibility of hip joint could be the most useful factors to assess the level of instrumental self-support ability.

**Key words:** elderly women living at home, instrumental activities of daily living, physical fitness test, knee-raising ability

Vital Statistics in Japan, published in 1992 (1) showed that the proportion of 65-year-old and over people in the total population of Japan is 12.6%. By the year 2025, this group is projected to comprise 25.8% of the Japanese population. As similar demographic aging trends have also been observed in other developed countries (1), elderly persons' physical fitness has become a matter of concern (2-4). Little is known about tests which could assess the physical fitness levels of the aged, although tests for persons in younger age groups have been established by many researchers (5).

Poor motor ability is related to poor self-support ability and also to a loss of the activities of daily living (ADL) in elderly persons (5-8). Borchelt and Steinhagen-Thiessen (7) noted the importance of analyses of the relationships between ADL and physical fitness tests. ADL can be classified into two levels: physical and/or basic ADL (PADL) and instrumental ADL (IADL) (9). PADL is used as an indicator of the ADL of the disabled elderly, since PADL consists of low level activity, such as bathing, dressing, and eating without help (10, 11). On the other hand, since IADL expresses more complex social functions (*e. g.*, activity in transportation, shopping, preparing meals), IADL status is more useful in evaluating the characteristics of elderly persons in the community who are not handicapped. "Quality of Life" and the level of independence of elderly persons is dependent upon their ability to do various instrumental activities (8).

Several reports have been presented on the association between PADL in institutionalized elderly persons and physical fitness tests (7, 8, 12, 13). Other studies (8, 12, 13) have found that grip strength reflects ADL in the

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population, whereas another (7) has reported no such association. Shibata (12) has indicated that elderly persons' ADL can be evaluated by standing on one leg with open eyes. On the other hand, there are few surveys of the relation between IADL status and physical fitness tests (14). It is still uncertain which physical fitness tests are most useful in assessing IADL in elderly persons.

Accordingly, this study was designed to evaluate the relationship between physical fitness tests and disability in IADL in elderly persons, and to determine the most useful test related to IADL of elderly persons in the community.

## Subjects and Methods

The subjects included 133 women aged 65 years or over, who lived at home in Y Town, near Himeji City in Hyogo Prefecture, Japan, where 12.8 % of the population in this town is 65 years old and over, similar to the national average for the entire Japanese in 1993. This study was limited to women, because they have relatively many things in common in a state of IADL. Men customarily do not assume many of the responsibilities for the work of daily living (*e. g.*, housework and preparing meals), leaving this work to women (15). The women in this study comprised all of the elderly females in Y town visiting the nursing home to participate in day services for the aged once every 2 weeks. According to the results of a medical check, the subjects did not have serious paralysis or a decrease of muscular strength due to cerebrovascular or musculoskeletal disease.

The survey was carried out in June and July of 1993. To verify basic cognitive functions, the subjects at a nursing home completed questionnaires by themselves, giving address, sex, date of birth, age, name and dates of the physical fitness tests. We then confirmed those answers using the day service application forms. We excluded five women whose answers were incorrect, leaving a sample size of 128 subjects.

IADL status was assessed by questionnaire, using part of an index of competence created by the Tokyo Metropolitan Institute of Gerontology (16), consisting of 13 items of elderly person's competence such as instrumental self-maintenance [Question (Q)1 to Q5], intellectual activity (Q6 to Q9), and social scale (Q10 to Q13). Among them, we employed a question concerning five instrumental functions: Q1, going out to use a train or bus; Q2, going shopping; Q3, preparing meals; Q4, making payments of bills; and Q5, obtaining receipts of postal savings and/or payments from bank accounts. We also used a question concerning eight functions to assess the overall competence level. The subjects were classified into two groups according to the disability level in competence: the dependent in IADL group (Dep) consisted of 49 persons (38.3 %) who were dependent in regard to at least one of the five functions, and the independent in IADL group (Ind) consisted of 79 persons (61.7 %) who were independent with regard to all five functions.

We carried out various physical fitness tests including measurement of height, body weight, grip strength, sitting stepping, standing on one leg with open eyes, standing on one leg with closed eyes, sit-and-reach test, and jumping reaction time. Body mass index (BMI) was calculated as body weight (kg)/height $(m)^2$. Sitting stepping was measured according to the test of Kimura *et al.* (17). Standing on one leg with open eyes was based on the test of Tokyo Metropolitan University (18). Other tests were carried out as outlined in the operation manual described by Himaru *et al.* (19).

As several researchers have indicated the importance of muscle strength and mobility of the lower extremities in evaluating elderly persons' health (20–22), we decided to add a knee-raising test to the above tests. The knee-raising test was carried out by modifying the knee extensor muscle endurance test (23), a field test used to measure leg muscle endurance. The procedure for the knee-raising test was as follows: subjects stood comfortably at a distance of 0.5 m from the wall, faced the wall, touched the wall with both hands to support the body, and then raised the dominant leg with the knee bent at 90 degrees. In the original knee extensor muscle endurance test, after trials for familiarization had been performed, the standing time was recorded with a stopwatch from the time the dominant foot left the floor until the non-dominant foot was displaced, the dominant leg touched the non-dominant leg, or the dominant leg touched the floor. However, because this knee-raising test may be too strenuous for most elderly people due to the long performance time, we measured the maximum distance (instead of standing time) from the floor to the center of the knee joint, and the subjects were allowed to immediately bring down their leg after the measurement of the maximum knee-raising height. The knee-raising height was corrected by the distance from the floor to the subject's spina iliaca anterior superior, since knee-raising height is influenced by the length of the lower limb. We computed a relative value, dividing knee-raising height by lower limb length. Reproducibility of the knee-raising test was examined in our investigation using the 19 subjects (75.2 ± 5.5 years of age, range 67–85) who agreed to participate in the study. The retest was conducted 2 weeks after the initial test session. We also measured knee extensor strength at a 90 degree knee flexion in the seated position (19), and the active range of motion in hip flexion-extension and in knee flexion (24).

In analysis of the data, the two-tailed Student's $t$-test and the $\chi^2$ test were used where applicable. A 0.05 probability level was taken as the level of significance. All physical fitness tests were divided into two categories according to their median value. The odds ratio (OR) and the 95 % confidence interval (CI) were calculated to assess the magnitude of the association of decrease in IADL with the physical fitness tests. Fujita and Hatano (15) and Kobayashi *et al.* (25, 26) reported that disability of IADL was found to be correlated most with advanced age in the elderly at home. Therefore, we adjusted the results in the cross table analysis for age (grouped by 5-year intervals), using the Mantel-Haenszel method. Multivariate analysis, using Hayashi's quantification method I and/or II, was employed to assess the independent effects of each fitness test on the decrease in IADL. The data were analyzed using the *Handbook of Statistical Analysis for Windows* (Multivariate Analysis) (27) and the HALBAU statistical software (28).

## Results

The mean with standard deviation of the index of competence (Q1 to Q13) of all subjects in this study was 10.4 ± 3.1.

Pearson's correlation analysis showed that the knee-raising test results and test-retest sessions had a significant relationship ($r = 0.94$, $P < 0.01$). There were positive correlations between the knee-raising test and knee extensor strength ($r = 0.75$, $P < 0.01$) and active range of motion in hip flexion-extension ($r = 0.80$, $P < 0.01$).

Table 1 shows the means with standard deviations of selected variables in all subjects, Dep and Ind groups for this study. The age distribution of the two IADL groups showed that people in the Dep group were older than those in the Ind group ($\chi^2 = 22.08$, df = 4, $P < 0.01$).

Table 2 shows the crude and age-adjusted ORs and the 95 % CIs for the relation between physical fitness tests and IADL. The following tests showed a significant relation to decreased IADL: knee-raising test (age-adjusted OR = 4.23, 95 % CI 1.81–9.87), height (age-adjusted OR = 4.09, 95 % CI 1.75–9.56), grip strength (age-adjusted OR = 3.68, 95 % CI 1.57–8.60), sit-and-

**Table 1** Selected variables of all subjects divided into dependent and independent in instrumental activities of daily living (IADL) groups

| Selected variables | All subjects (n = 128) | | IADL group | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Dep[a] (n = 49) | | | Ind[b] (n = 79) | | |
| | Mean | SD | Mean | SD | Range | Mean | SD | Range |
| Age (years) | 77.1 | 5.9 | 80.1 | 6.2 | 65–91 | 75.3 | 4.9 | 65–87 |
| Height (cm) | 143.8 | 5.9 | 140.7 | 4.9 | 130.5–151.0 | 145.7 | 5.7 | 133.0–162.0 |
| Body weight (kg) | 45.3 | 8.3 | 42.1 | 6.8 | 28.5–60.0 | 47.3 | 8.4 | 30.5–65.0 |
| Body mass index (kg/m²) | 21.9 | 3.4 | 21.3 | 3.3 | 16.7–30.5 | 22.2 | 3.5 | 14.9–32.3 |
| Grip strength (kg) | 15.6 | 5.2 | 13.2 | 4.4 | 4.0–26.0 | 17.1 | 5.0 | 5.0 28.5 |
| Sitting stepping (times/20 sec) | 20.7 | 5.3 | 19.0 | 5.0 | 11–31 | 21.7 | 5.2 | 11 33 |
| Standing on one leg with open eyes (sec) | 11.7 | 13.7 | 6.6 | 10.0 | 0.3–120.0 | 14.9 | 14.8 | 0.4–120.0 |
| Standing on one leg with closed eyes (sec) | 2.7 | 3.2 | 1.7 | 1.9 | 0.3 8.9 | 3.3 | 3.7 | 0.2–26.4 |
| Sit-and-reach test (cm) | 5.4 | 7.4 | 1.9 | 7.3 | 16.7–17.0 | 7.6 | 6.5 | –9.5 23.4 |
| Jumping reaction time (sec) | 0.777 | 0.273 | 0.876 | 0.305 | 0.444–2.000 | 0.715 | 0.230 | 0.332–1.325 |
| Knee-raising test (%) | 98.4 | 9.8 | 93.3 | 10.0 | 62.7–108.4 | 101.5 | 8.3 | 82.3–120.9 |

*a*: Dependence in regard to at least one of the five questions (Q1: Going out to use a train or bus, Q2: Going shopping, Q3: Preparing meals, Q4: Making payments of bills, Q5: Obtaining receipts of postal savings and/or payments from bank accounts).
*b*: Independence in regard to all five questions.

**Table 2** Crude and age-adjusted odds ratios and 95% confidence intervals for the association between physical fitness tests and IADL status in elderly women (dependent in IADL; n = 49, independent in IADL; n = 79)

| Categories of variables | Group | | Crude odds ratios | 95% CI[c] | Age-adjusted[d] odds ratios | 95% CI |
|---|---|---|---|---|---|---|
| | Dep[a] No.(%) | Ind[b] No.(%) | | | | |
| Height (cm) | | | | | | |
| 144.0- | 11 (22.4) | 51 (64.6) | 1.00 | Referent | 1.00 | Referent |
| -143.9 | 38 (77.6) | 28 (35.4) | 6.29 | 2.60-15.50 | 4.09** | 1.75-9.56 |
| Body weight (kg) | | | | | | |
| 44.1- | 16 (32.7) | 47 (59.5) | 1.00 | Referent | 1.00 | Referent |
| -44.0 | 33 (67.3) | 32 (40.5) | 3.03 | 1.35-6.87 | 1.98 | 0.89-4.42 |
| Body mass index (kg/m²) | | | | | | |
| 21.8- | 18 (36.7) | 45 (57.0) | 1.00 | Referent | 1.00 | Referent |
| -21.7 | 31 (63.3) | 34 (43.0) | 2.28 | 1.03-5.07 | 1.67 | 0.76-3.64 |
| Grip stength (kg) | | | | | | |
| 16.0- | 12 (24.5) | 52 (65.8) | 1.00 | Referent | 1.00 | Referent |
| 15.9 | 37 (75.5) | 27 (34.2) | 5.94 | 2.49-14.38 | 3.68** | 1.57-8.60 |
| Sitting stepping (times/20 sec) | | | | | | |
| 21- | 16 (32.7) | 39 (49.4) | 1.00 | Referent | 1.00 | Referent |
| -20 | 33 (67.3) | 40 (50.6) | 2.01 | 0.90-4.53 | 1.25 | 0.54-2.90 |
| Standing on one leg with open eyes (sec) | | | | | | |
| 6.0 | 15 (30.6) | 49 (62.0) | 1.00 | Referent | 1.00 | Referent |
| -5.9 | 34 (69.4) | 30 (38.0) | 3.70 | 1.63-8.52 | 2.06 | 0.86-4.93 |
| Standing on one leg with closed eyes (sec) | | | | | | |
| 1.8- | 14 (28.6) | 50 (63.3) | 1.00 | Referent | 1.00 | Referent |
| 1.7 | 35 (71.4) | 29 (36.7) | 4.31 | 1.87-10.06 | 2.56* | 1.09-5.97 |
| Sit-and-reach test (cm) | | | | | | |
| 6.1- | 14 (28.6) | 49 (62.0) | 1.00 | Referent | 1.00 | Referent |
| -6.0 | 35 (71.4) | 30 (38.0) | 4.08 | 1.78-9.51 | 2.76* | 1.20-6.34 |
| Jumping reaction time (sec) | | | | | | |
| -0.730 | 18 (36.7) | 47 (59.5) | 1.00 | Referent | 1.00 | Referent |
| 0.731- | 31 (63.3) | 32 (40.5) | 2.53 | 1.14-5.65 | 2.21 | 1.01-4.85 |
| Knee-raising test (%) | | | | | | |
| 99.5- | 11 (22.4) | 50 (63.3) | 1.00 | Referent | 1.00 | Referent |
| -99.4 | 38 (77.6) | 29 (36.7) | 5.96 | 2.47-14.63 | 4.23** | 1.81-9.87 |

*a*: Dependence in regard to at least one of the five questions (Q1: Going out to use a train or bus, Q2: Going shopping, Q3: Preparing meals, Q4: Making payments of bills, Q5: Obtaining receipts of postal savings and/or payments from bank accounts).
*b*: Independence in regard to all five questions.
*c*: CI, confidence interval.
*d*: Odds ratios were adjusted for age by the Mantel-Haenszel method. $^{**}P < 0.01$, $^{*}P < 0.05$.
IADL: See Table 1.

reach test (age-adjusted OR = 2.76, 95 % CI 1.20-6.34), and standing on one leg with closed eyes (age-adjusted OR = 2.56, 95 % CI 1.09-5.97). In particular, low values for the knee-raising test and height were significantly

**Table 3** Pearson's correlations among age and physical fitness tests

| Variables | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. | 11. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Age | | | | | | | | | | | |
| 2. Height | -0.373** | | | | | | | | | | |
| 3. Body weight | -0.326** | 0.522** | | | | | | | | | |
| 4. Body mass index | -0.185* | 0.074 | 0.886** | | | | | | | | |
| 5. Grip strength | -0.384** | 0.558** | 0.341** | 0.104 | | | | | | | |
| 6. Sitting stepping | 0.279** | 0.260** | 0.121 | 0.001 | 0.435** | | | | | | |
| 7. Standing on one leg with open eyes | -0.406** | 0.304** | 0.179* | 0.046 | 0.503** | 0.489** | | | | | |
| 8. Standing on one leg with closed eyes | -0.408** | 0.271** | 0.212* | 0.098 | 0.374** | 0.444** | 0.452** | | | | |
| 9. Sit-and-reach test | -0.314** | 0.340** | 0.315** | 0.187* | 0.343** | 0.047 | 0.229** | 0.155 | | | |
| 10. Jumping reaction time | 0.226* | -0.288** | -0.129 | 0.009 | -0.491** | -0.524** | -0.343** | -0.306** | -0.159 | | |
| 11. Knee-raising test | -0.331** | 0.304** | -0.008 | 0.163 | 0.335** | 0.420** | 0.352** | 0.241** | 0.321** | -0.418** | |

**$P < 0.01$, *$P < 0.05$

**Table 4** Multivariate analysis, using Hayashi's quantification method I, for age and physical fitness tests related to decrease in IADL in elderly women (n = 128)

| Categories of explanatory variables | Quantity | Partial correlation coefficient | Categories of explanatory variables | Quantity | Partial correlation coefficient |
|---|---|---|---|---|---|
| Age (years) | | | Standing on one leg with open eyes (sec) | | |
| -76 | -0.0962 | 0.0687 | 6.1- | -0.0865 | 0.0513 |
| 77- | 0.1057 | | -6.0 | 0.0865 | |
| Height (cm) | | | Standing on one leg with closed eyes (sec) | | |
| 144.0- | -0.2751 | 0.1812 | 1.9- | -0.0966 | 0.0521 |
| -143.9 | 0.2928 | | -1.8 | 0.0966 | |
| Body mass index (kg/m$^2$) | | | Sit-and-reach test (cm) | | |
| 21.8- | -0.1916 | 0.1468 | 6.1 | -0.2601 | 0.1863 |
| -21.7 | 0.1977 | | -6.0 | 0.2684 | |
| Grip strength (kg) | | | Jumping reaction time (sec) | | |
| 16.0- | -0.1630 | 0.1009 | -0.730 | -0.1103 | 0.0710 |
| 15.9 | 0.1630 | | 0.731- | 0.1069 | |
| Sitting stepping (times/20 sec) | | | Knee-raising test (%) | | |
| 21- | -0.0173 | 0.0120 | 99.5- | -0.4042 | 0.2835 |
| -20 | 0.0230 | | -99.4 | 0.4440 | |
| | | | Correlation ratio | | 37.4% |
| | | | Multiple correlation coefficient | | 0.6116 |

IADL: See Table 1.

associated with decreased IADL. On the other hand, no significant associations were found between decreased IADL and measurements including body weight, BMI, sitting stepping, standing on one leg with open eyes, and jumping reaction time.

Table 3 shows Pearson's correlations among age and physical fitness tests. There was a high correlation between body weight and BMI ($r = 0.886$, $P < 0.01$). Among the tests, we excluded body weight to prevent multicollinearity when employing multivariate analysis.

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Table 4 shows the independent effects of physical fitness tests associated with the decrease in IADL assessed by multivariate analysis using Hayashi's quantification method I. The knee-raising test was the most highly correlated with IADL; the partial correlation coefficient was 0.2835.

Table 5 shows the number of subjects, unable and able to perform each IADL function. Table 6 shows the age-adjusted ORs and 95% CIs for the association between physical fitness tests and each of the five functions. There were strong correlations between low values for knee-raising test and decreases in Q1, Q2, Q4 and Q5 functions, respectively. Age-adjusted ORs were 3.62 (95% CI 1.35-9.74), 7.76 (95% CI 1.68-35.77), 9.02 (95% CI 2.35-39.21) and 5.62 (95% CI 1.73-18.27). There was a strong correlation between sitting stepping and Q3 function. Age-adjusted OR was 6.08 (95% CI 1.36-27.18). Table 7 shows the results of multivariate analysis using Hayashi's quantification method II in which age and physical fitness tests related to the decrease in each of the five functions were evaluated. BMI was the most highly associated with a decrease in Q1 function; the partial correlation coefficient was 0.2241, while the knee-raising test was most highly associated with a decrease in Q2 to Q5 functions respectively; the partial correlation coefficients were 0.2236, 0.2133, 0.2708 and 0.1691.

**Table 5** Proportion of level in IADL, according to the items of question

| Items of question | Group | | | |
|---|---|---|---|---|
| | Unable | | Able | |
| | No. | % | No. | % |
| Q1: Going out to use a train or bus | 34 | 26.6 | 94 | 73.4 |
| Q2: Going shopping | 20 | 15.6 | 108 | 84.4 |
| Q3: Preparing meals | 21 | 16.4 | 107 | 83.6 |
| Q4: Making payments of bills | 22 | 17.2 | 106 | 82.8 |
| Q5: Obtaining receipts of postal savings and/or payments from bank accounts. | 26 | 20.3 | 102 | 79.7 |

IADL: See Table 1.

## Discussion

In the present study, we examined the relationship between IADL and several physical fitness tests in 128 elderly women. As only women living at home who visited a nursing home for day services were entered into the study, we compared the index of competence and the physical fitness level in the present study with those in the other studies (16, 17, 29, 30). It was confirmed that there

**Table 6** Age-adjusted odds ratios and 95% confidence intervals for the association between physical fitness tests and each of the five functions in elderly women

| Selected variables | Items of question[a] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Q1 | | Q2 | | Q3 | | Q4 | | Q5 | |
| | Age-adjusted[b] odds ratio | 95% CI[c] | Age-adjusted odds ratio | 95% CI | Age-adjusted odds ratio | 95% CI | Age-adjusted odds ratio | 95% CI | Age-adjusted odds ratio | 95% CI |
| Height (cm) | 2.66 | 1.05-6.77 | 4.95* | 1.33-18.37 | 4.02* | 1.11-14.55 | 7.87** | 1.86-33.20 | 5.09** | 1.62-15.97 |
| Body weight (kg) | 2.78* | 1.09-7.12 | 2.40 | 0.81-7.12 | 3.07 | 0.93-10.8 | 2.95 | 0.96-9.09 | 2.16 | 0.83-5.61 |
| Body mass index (kg/m$^2$) | 2.66* | 1.07-6.65 | 2.02 | 0.73-5.59 | 2.08 | 0.73-5.96 | 1.11 | 0.42-2.90 | 1.50 | 0.63-3.57 |
| Grip strength (kg) | 2.27 | 0.90-5.73 | 5.58** | 1.54-20.24 | 4.31* | 1.24-14.99 | 8.16** | 2.07-32.18 | 4.34** | 1.49-12.68 |
| Sitting stepping (times/20 sec) | 1.06 | 0.41-2.71 | 4.33* | 1.18-15.80 | 6.08* | 1.36-27.18 | 3.86 | 1.08-13.75 | 1.82 | 0.69-4.81 |
| Standing on one leg with open eyes (sec) | 2.41 | 0.86-6.79 | 2.16 | 0.66-7.04 | 1.50 | 0.49-4.55 | 2.17 | 0.72-6.50 | 2.84 | 0.94-8.54 |
| Standing on one leg with closed eyes (sec) | 2.57 | 0.94-7.01 | 4.07* | 1.13-14.75 | 5.01* | 1.22-20.62 | 3.32 | 0.96-11.46 | 3.31* | 1.10-9.90 |
| Sit-and-reach test (cm) | 2.79 | 1.07-7.29 | 3.39 | 1.02-11.33 | 3.04 | 0.90-10.31 | 5.31* | 1.47-19.21 | 4.29* | 1.40-13.16 |
| Jumping reaction time (sec) | 2.31 | 0.95-5.64 | 3.24* | 1.12-9.39 | 2.56 | 0.89-7.35 | 3.08* | 1.09-8.73 | 2.60 | 1.01-6.73 |
| Knee-raising test (%) | 3.62* | 1.35-9.74 | 7.76** | 1.68-35.77 | 5.66** | 1.37-23.50 | 9.02** | 2.35-39.21 | 5.62** | 1.73-18.27 |

a: The number of subjects, unable and able, are presented in Table 5. Q1: Going out to use a train or bus, Q2: Going shopping, Q3: Preparing meals, Q4: Making payments of bills, Q5: Obtaining receipts of postal savings and/or payments from bank accounts.
b: Odds ratios were adjusted for age by the Mantel-Haenszel method. $^{**}P < 0.01$, $^{*}P < 0.05$.
c: CI, confidence interval.

**Table 7** Multivariate analysis, using Hayashi's quantification method II, for age and physical fitness tests related to decrease in each of the five functions in elderly women

| Selected variables | Q1 Range | Q1 Partial correlation coefficient | Q2 Range | Q2 Partial correlation coefficient | Q3 Range | Q3 Partial correlation coefficient | Q4 Range | Q4 Partial correlation coefficient | Q5 Range | Q5 Partial correlation coefficient |
|---|---|---|---|---|---|---|---|---|---|---|
| Age (years) | 0.4318 | 0.1100 | 0.1649 | 0.0358 | 0.2670 | 0.0644 | 0.1122 | 0.0298 | 0.4570 | 0.1054 |
| Height (cm) | 0.3588 | 0.0871 | 0.6272 | 0.1287 | 0.5066 | 0.1157 | 0.7644 | 0.1897 | 0.6241 | 0.1364 |
| Body mass index (kg/m$^2$) | 0.8027 | 0.2241 | 0.4827 | 0.1166 | 0.4277 | 0.1148 | 0.0073 | 0.0022 | 0.1785 | 0.0462 |
| Grip strength (kg) | 0.0117 | 0.0027 | 0.3863 | 0.0764 | 0.2455 | 0.0540 | 0.6001 | 0.1439 | 0.4595 | 0.0967 |
| Sitting stepping (times/20 sec) | 0.7697 | 0.1698 | 0.4504 | 0.0852 | 0.6171 | 0.1292 | 0.3483 | 0.0806 | 0.2526 | 0.0511 |
| Standing on one leg with open eyes (sec) | 0.3009 | 0.0670 | 0.4131 | 0.0779 | 0.5506 | 0.1151 | 0.3906 | 0.0900 | 0.0039 | 0.0008 |
| Standing on one leg with closed eyes (sec) | 0.4993 | 0.1008 | 0.0762 | 0.0131 | 0.3394 | 0.0649 | 0.1449 | 0.0305 | 0.1539 | 0.0283 |
| Sit-and-reach test (cm) | 0.4641 | 0.1242 | 0.4803 | 0.1092 | 0.5317 | 0.1341 | 0.6039 | 0.1665 | 0.5322 | 0.1288 |
| Jumping reaction time (sec) | 0.2710 | 0.0667 | 0.2838 | 0.0592 | 0.0104 | 0.0024 | 0.1639 | 0.0418 | 0.2880 | 0.0641 |
| Knee-raising test (%) | 0.8377 | 0.2143 | 1.0320 | 0.2236 | 0.8837 | 0.2133 | 1.0358 | 0.2708 | 0.7237 | 0.1691 |
| Correlation ratio | | 27.5% | | 21.5% | | 25.3% | | 29.0% | | 23.7% |

Items of question[a]

[a]: The number of subjects, unable and able, are presented in Table 5. Q1: Going out to use a train or bus, Q2: Going shopping, Q3: Preparing meals, Q4: Making payments of bills, Q5: Obtaining receipts of postal savings and/or payments from bank accounts.

were no significant differences in the mean for the index of competence between all subjects in this study and that in another study (n = 3,690, 10.8 ± 3.5) (16). There were no significant differences between all subjects of the present study and those in other studies (17, 29, 30) in terms of the results of physical fitness tests, except for sitting stepping values which were lower than those reported elsewhere (17, 30). Therefore, we demonstrated that the level of competence and physical fitness in the present elderly population were within normal ranges.

The knee-raising test and height were found to be strongly associated with a decrease in IADL in elderly women, as assessed by ORs. The multivariate analysis in this study showed that the extent of the decrease in IADL was highly correlated with results in the knee-raising test. This study confirmed that the knee-raising test is significantly correlated with knee extensor strength and flexibility of the hip joint. Several researchers (6, 30) have indicated that elderly women's physical activity levels were positively correlated with knee extensor strength. We demonstrated that knee-raising ability, which reflects the strength of the quadriceps muscles and the mobility of the hip joint, is important in the instrumental maintenance of ADL in the aged. A low level of knee-raising appears to be the strongest factor indicating decreased IADL. One possible explanation of the significant relation is that the questionnaire of IADL consists of outdoor activities of daily living such as physical locomotion ability. Therefore, lower extremity function might affect IADL status in the community. Shortness of stature due to age-related changes in the spine is a rather obvious characteristic of the elderly (31, 32). Spinal curvature is a risk factor in the decreased ability of elderly persons to perform ADL (33). Changes in bone structure could also influence decreases in IADL in elderly women. On the other hand, the decrease of stature is more significant in women than in men between 60 and 80 years of age because of the greater vulnerability to bone loss among elderly women (32). This factor could account for the strong association between height and IADL status observed in our study.

Other tests that showed a significant relation with disability in IADL were grip strength, the sit-and-reach, and standing on one leg with closed eyes tests. Several reports have shown a close relationship between grip strength and PADL in older populations (8, 12, 13). It was confirmed that grip strength is an effective measure assessing the IADL status in elderly women. From the results of previous (8, 12, 13) and present studies, it is inferred that a good grip strength is an important factor in maintaining independence in elderly person's daily living activities. The sit-and-reach test has also been shown to be associated with ADL in elderly women (30). A similar finding was obtained in our study. Flexibility of the entire body needs to be maintained to allow independent instrumental ability in the aged. Kim *et al.* (30) reported that the time that a person can stand on one leg with open eyes is a better index than the results of the same test performed with closed eyes for evaluating ADL status in elderly women. The results in this study do not support their finding. Our data indicated that the measurement of the time of the standing on one leg with closed eyes could be a more effective test than the same measurement with open eyes to assess IADL status, and this is supported by Washburn *et al.* (6).

We did not find significant associations between body weight, BMI, sitting stepping, standing on one leg with open eyes, and jumping reaction time and decrease in IADL. Lapidus *et al.* (34) suggested that being overweight and obesity are associated with health problems including hypertension and hyperlipidemia in middle age. On the other hand, Pescatello and DiPietro (2) reported that a relative weight slightly above average may actually reduce cardiovascular risk and overall mortality among older individuals. Larsson (35) also noted that it remains unclear whether the increased risk of morbidity and mortality due to obesity continues into older adulthood. In this study, we demonstrated that body weight and BMI do not appear to be related to instrumental self-maintenance ability in elderly women. Therefore, mild obesity may not necessarily be hazardous to the health status of elderly persons. However, further investigations are needed to verify the issue concerning the significance of obesity in an elderly person's lower extremities. Sitting stepping and jumping reaction time show the agility of lower extremities and total body reaction (19). From the results in this study, it is considered that these functions are less important in IADL in elderly women.

The following limitations of this study should be noted: in the United States, the National Arthritis Data Workgroup (36) has reported that the incidence of osteoarthritis of the knee and hip joint were higher in females than in males in middle aged and older populations. In Japan, Koga and Tamaki (37, 38) and Masuhara *et al.* (39) also reported similar findings. As osteoarthritis may influence knee-raising ability, the observed association between knee-raising test and IADL status could have been overestimated. Only physical fitness tests were examined; we left the other correlating factors (*e.g.*, mental health, educational background, family structure, marital status, work, regional differences), out of consideration in this investigation. As the influence of these factors is unclear, we should identify these issues in the future.

Despite these limitations, the present cross-sectional study quantitatively demonstrates the relationships between physical fitness tests and disability in IADL. These results suggest that knee extensor strength, mobility of hip joint and knee-raising ability are essential factors for the maintenance of IADL in elderly women. Although there is the fear that an increase in serious illness such as cerebrovascular disease in the future will lead to decreased IADL, research should continue to focus on prospective studies of particular physical fitness tests for predicting decreases in IADL in older populations.

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