



Longitudinal Relationships between Ability to Perform Activities of Daily Living and Mobility in Community-Living Elderly Over 75 years Old

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博士論文

Longitudinal Relationships between Ability to Perform Activities of Daily Living and
Mobility in Community-Living Elderly Over 75 Years Old

「地域に居住する後期高齢者における日常生活活動の自立度と移動能力の縦断的な関係性」

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**Longitudinal Relationships between Ability to Perform Activities of Daily Living and
Mobility in Community-Living Elderly Over 75 Years Old**

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Abstract: Previous studies suggested that mobility is a target for preventing decline in the ability to perform basic activities of daily living (ADLs) in elderly people. Despite the fact that mobility as well as ADL ability decline with aging, those studies have focused only on the relationships between initial level of mobility and subsequent decline of ADL ability. The purpose of this study was to clarify the longitudinal relationships between ADL ability and mobility in elderly people. ADL ability and mobility were assessed in 422 non-institutionalized Japanese elderly residents aged 75 years or older by the Katz index and the Rivermead mobility index at baseline and 18-month follow-up. Longitudinal relationships were examined using a cross-lagged structural equation model and latent growth modeling. The results indicated that mobility affects future ADL ability, whereas ADL ability has almost no feedback effect on future mobility, and that only change in mobility affects the decline in ADL ability. These findings suggest that maintenance of the level of mobility will contribute to maintenance of ADL ability in elderly people.

Key Words: Elderly, prevention of disability, mobility, crossed-lagged structural equation model, latent growth modeling

Introduction

Aging society is a major problem in many developed countries.¹⁾ Japan confronted with a particularly serious problem, the number of people aged 65 years or over having reached 19.5% of the total population in 2004. Almost 4 million people are now receiving benefits from the Long-term Care Insurance System established in Japan for elderly people, and the number of people receiving benefits from the insurance system is expected to continue rising. It is well known that the functional status of elderly people declines with advance of age and that the rate of decline increases with aging.²⁾ Each year, about 10% of nondisabled, community-dwelling adults aged 75 years or older lose independence in their ability to perform basic activities of daily living (ADLs), such as feeding, dressing and bathing.³⁻⁵⁾ This functional dependence, in turn, is associated with increased

mortality and leads to additional adverse outcomes, such as hospitalization, nursing home placement, and greater use of formal and informal home services.^{3,4,6)} Thus, home services for elderly people should be aimed at providing support for disabled people as well as preventive services for nondisabled people in order to maintain their function and reduce morbidity and mortality rates.

Prevention of disability is a particularly important issue in research on aging.⁷⁾ Risk factors and predictors of disability have been extensively investigated in previous studies.²⁾ Many studies have focused on ADLs as indices of disability, because ADLs represent the basic set of care needs essential to independent living.⁸⁾

Major well-known factors affecting ADL ability include sociodemographic factors, cognitive impairments, physical disability and health status, and psychosocial and environmental factors.^{2,9)} Sociodemographic factors include age, gender, race, marital status, education and income.^{4,10,11)} Physical dis-

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ability and health status factors include paralysis, hearing and visual function impairments,^{12,13)} limitations on physical activities,^{5, 14-17)} impairment-causing diseases such as stroke, heart disease and musculoskeletal disease,^{18, 19)} high medication use,²⁰⁾ poor self-rated health,²¹⁾ falls and fall-related injuries.²²⁾ Psychosocial and environmental factors affecting ADL ability include aspects of psychological health such as anxiety and depression and social factors such as low level of social activities, low frequency of social contact and low level of social support.^{10, 19, 23)}

Some studies in recent years have focused on the transition from health to disability.⁷⁾ Several models of transition from a healthy state to a state of disability have been proposed, and functional limitations have been suggested as the pathway from illness to disability.²⁴⁻²⁸⁾ One of the most well-known models is the Disablement Process model proposed by Verbrugge and Jette.²⁸⁾ The pathway in their model starts with pathology and progresses to impairments and then to functional limitations and finally to disability. Disability in their model is defined as difficulty in performing any activities of daily life.²⁸⁾ Functional limitations in their model are considered to be restrictions in performing basic physical and mental actions used in daily life, such as restrictions in mobility.²⁸⁾ In the model of Verbrugge and Jette,²⁸⁾ most of the proposed risk factors and predictors of disability are not directly modifiable, but mobility, an index of functional limitations, is a modifiable risk factor.⁵⁾ For this reason the Disablement Process model has been used in recent studies to examine longitudinal relationships between ADL ability and mobility. Most studies have shown that there is a significant association between mobility and prognosis of ADL ability.^{5, 14-17)} According to the Disablement Process model, mobility difficulty first occurs as a functional limitation and this causes disability in performance of ADLs.

Previous studies, however, have shown the existence of three methodological issues. Firstly, the possibility of reciprocal causality in the relationships between ADL ability and mobility has not been ex-

amined. In the Disablement Process model, it is assumed that not only do functional limitations lead to disability but also that there exist feedback effects by which disability causes functional limitations and function impairment.²⁸⁾ Examination of the relationships between ADLs and mobility must also take into account the possible effect of ADL ability on mobility. Secondly, there has been no investigation taking into account the fact that both ADL ability and mobility change over time. It has been shown that mobility as well as ADL ability declines with aging.²⁹⁻³¹⁾ However, studies have focused only on the relationships between mobility at a baseline time point and abilities to perform ADLs at a follow-up time point.^{5, 14-17)} Moreover, analyses used in previous studies have been limited to multiple linear regression analysis, multiple logistic-regression analysis, survival analysis and correlation analysis. The fact that both ADL ability and mobility change over time should be taken into account. The third issue is the indices used for mobility. Indices for mobility investigated in previous studies include walking speed,¹⁴⁻¹⁶⁾ results of performance tests such as the timed up and go (TUG) test,⁵⁾ and stair climbing ability.¹⁵⁾ However, the definition of mobility is not limited to specific movements such as walking or climbing stairs. WHO²⁵⁾ defined mobility as “the individual's ability to move about effectively in his surroundings” (WHO ICIDH, 1980). Mobility was defined by Van Bennekom, Jelles, and Lankhorst³²⁾ as “a process of moving oneself and of changing and maintaining postures.” Creel, Light, and Thigpen³³⁾ defined mobility as “a person's ability to maneuver his or her body independently in order to accomplish everyday tasks.” Femia et al.¹⁷⁾ carried out a study on mobility defined by the following 8 functions: getting around indoors, getting around outdoors, going up stairs, bending over, raising the hands above the shoulders, getting in and out of bed, transferring from a bed to a chair, and picking up small items. There is a need for investigation of mobility using a standard scale by which various functions related to mobility can be assessed.

In the present study, the longitudinal relation-

ships between ADL ability and mobility were investigated in elderly people in order to determine whether mobility should be the focus for prevention of disability in performance of ADLs. The purposes of this study were 1) to determine whether there is reciprocal causality in the relationships between ADL ability and mobility and 2) to determine the relationship between changes in ADL ability and mobility over time by using latent growth modeling, which utilizes structural equation modeling, a method of statistical analysis widely accepted in recent years as a useful tool for investigating relationships between elements that change longitudinally.

Methods

SUBJECTS

The data for this study were obtained from the baseline survey (Wave 1 survey; W1, December 2002) and the follow-up survey (Wave 2 survey; W2, June 2004) of the Preventive Care Project, which was a longitudinal, multidisciplinary research project of the aging population. The follow-up interval was 18 months. Target population of the project were 907 non-institutionalized elderly residents aged 75 years or older living in a town located in a rural area (population of about 6,800) in the western part of Japan. The proportion of inhabitants aged 65 or older (33.0%) was higher than that of the national average (19.0%; Japanese Statistics Bureau, 2002).

The data were collected by a public health nurse in each participant's residence place. In the W1 and W2 surveys, information on sociodemographic and health-related variables, ADLs, and mobility was collected using a self-administered questionnaire. Sociodemographic variables included age, gender, living status, and presence of need for public-care of the Long-term Care Insurance System. Health-related variables included chronic conditions and cognitive status. Chronic conditions were self-reported physician-diagnosed conditions: hypertension, diabetes mellitus, cerebrovascular disease, Parkinson's disease, arthritis, hip fracture, rheumatoid arthritis, visual disturbance and respiratory disease. Cognitive status was assessed according to

Karasawa's clinical criteria for grading of dementia.³⁴⁾ Karasawa's clinical criteria, which are widely used for epidemiological research in Japan, classifies dementia into 6 grades: normal, subnormal, and cognitive dysfunction (mild, moderate, severe and very severe).

Among 907 non-institutionalized elderly residents, 868 (95.7%) agreed to participate in W1 survey, 627 (69.1%) participated in both W1 and W2 surveys. The participants were informed that all information was to be used for research purposes only and to be handled confidentially. The study was approved by the Ethical Committee of Okayama Prefectural University.

For the present study, participants with dementia were excluded from analysis because they were expected to have declined functional abilities as part of the disease process.²⁾ Considering the effect of mobility disability on performance of ADLs, nonambulatory residents were also excluded. Of the 627 participants in both W1 and W2 surveys, 20 (3.1%) were classified into cognitive dysfunction by Karasawa's clinical criteria, and 97 (15.4%) were not able to walk inside in the W1 survey. Data obtained from 102 (16.2%) of the remaining 524 participants were excluded from analysis because of missing observation (s) on item (s) of the index. The remaining 422 (67.3%) subjects formed our study population. Compared with these subjects, excluded participants were more likely to have poor medical conditions.

INSTRUMENTS

ADLs. ADL abilities were assessed by using six questions from the Katz Activities of Daily Living Scale (Katz index).³⁵⁾ The Katz index tests the level of functional independence in six categories: bathing, dressing, toileting, transferring, continence, and feeding. Responses to each item were dichotomized, with a score of 1 representing ability to perform a task without human help and a score of 0 indicating the need for human help or inability to perform the task. Scores were summed, creating a scale ranging from 0 to 6, with higher scores meaning better function. This is the most widely used scale for assessment of ability to perform ADLs, and the reli-

ability and validity of the scale have been supported.³⁵⁾

Mobility. Mobility was assessed by using the Rivermead mobility index (RMI).³⁶⁾ The items of this scale were as follows: turning over in bed, changing from a lying position to a sitting position, maintaining sitting balance, standing up from a sitting position, standing unsupported, transferring, walking inside with an aid if needed, managing stairs, walking outside on even ground, walking inside with no aid, picking up something from the floor, walking outside over uneven ground, bathing, going up and down four steps with no rail, and running 10 m without limping. The use of the RMI enables a comprehensive assessment of mobility based on the WHO definition of mobility (WHO ICIDH, 1980) for a range of easy to difficult tasks. This scale has been shown to have high levels of inter-rater and test-retest reliability and high-correlations with Barthel's Index, Berg's Balance Scale and maximum walking speed.³⁶⁾ It has been proved to be a unidimensional scale by a Mokken scale analysis.³⁶⁾ Scores were summed, creating a scale ranging from 0 to 15, with higher scores indicating greater mobility.

DATA ANALYSIS

Overview. In the first descriptive stage of analysis, sociodemographic characteristics, medical conditions, ADL ability and mobility were each analyzed the transition from W1 to W2 using Wilcoxon's test, chi-square test, and Fisher's exact probability test.

Reciprocal causality in the relationships between ADL ability and mobility were investigated using a cross-lagged structural equation model,^{37,38)} and then the results were used to investigate longitudinal relationships between ADL ability and mobility using latent growth modeling.³⁹⁻⁴¹⁾ As a framework for these analyses, we used the AMOS 4.0 program⁴¹⁾ for structural equation modeling (SEM) with latent variables. SEM produces an estimated covariance matrix based on the hypothesized model. This estimated matrix can be evaluated against the observed sample covariance matrix to determine

whether the hypothesized model is an acceptable representation of the observed data. SEM analyses were performed using maximum likelihood estimation. We evaluated goodness-of-fit indices to determine the fit of models. As a general rule, an acceptable fit is indicated by a chi-square probability value of $p > .05$, a comparative fit index (*CFI*) of $> .95$, a Tucker-Lewis index (*TLI*) of $> .95$, a root-mean-square error of approximation (*RMSEA*) of $< .05$, and a *PCLOSE* (test of the null hypothesis that *RMSEA* is no greater than .05) of $> .05$.⁴¹⁾

Cross-lagged structural equation model. We first examined the reciprocal causality in relationships between ADL ability and mobility. The following three conditions must generally be met to show causality between the two variables X and Y: 1) temporality, 2) strength of correlation and 3) direct relation.³⁸⁾ To overcome problems of reversed causation and confounding variables in research on causality, it is recommended to use a linear structural equations approach, which includes reversed effects and confounding variables.⁴²⁾ The General Linear Model, instrumental variable approaches and cross-lagged structural equation models were used to estimate reciprocal effect. Among them, the cross-lagged structural equation model^{37,38,43)} is extensively used for investigating reciprocal causality, and it provides an estimate of the predictive association between two variables over time under the conditions that those variables at follow-up are affected by their respective variables at baseline.

The cross-lagged structural equation model is comprised of the cross-lagged effect of each variable of interest on the other(s) and the autocorrelation of each variable with its lagged measurement.^{37,38)} We estimated the lagged effects of ADLs at W1 on ADLs at W2 and the effect of mobility at W1 on mobility at W2 as well as the cross-lagged effects of ADLs at W1 on mobility at W2 and of mobility at W1 on ADLs at W2. Additionally, to control the confounding effects of age and gender, we carried out analysis with one-way paths in the model from age at W1 and gender (1 = female; 0 = male) to ADLs and mobility at W1 and W2, respectively.

Latent growth modeling. We used LGM analysis to examine the longitudinal relationships between ADL ability and mobility. LGM defines change over time in terms of unobserved latent factors and thus fits into the general structural equation modeling framework.^{39,41)} The basic LGM comprises two latent factors, with repeated measures of the construct over time as indicators. Latent factors representing intercept and slope components are extracted from two observations across time, that is, baseline (W1) and follow-up (W2) for ADLs and mobility variables. The first latent factor defines the intercept, which represents the initial status of the growth curve at W1. The second latent factor defines the linear slope, which represents the rate of change over the period of 18 months. The means of these latent intercepts and slope factors represent the group of growth parameters and are overall measures of the intercept and slope for all subjects.

The model was constructed on the basis of paths showing statistically significant correlations in

the first analysis using the cross-lagged structural equation model. In addition, significant paths to ADL ability or mobility at W2 were introduced into the model as paths directed to slope factors. Age and gender (1 = female; 0 = male) were also introduced into the model. Factor loadings of the intercept component to all observations were fixed to 1, and we defined the linear slope component by fixing those parameters to 0 and 1 for W1 and W2, respectively.⁴⁰⁾ Moreover, since data obtained at two time points were used in this study, the item uniquenesses of observed variables were fixed to 0.⁴⁰⁾

Results

DESCRIPTIVE EPIDEMIOLOGY OF ADL ABILITY AND MOBILITY

Table 1 shows the sociodemographic characteristics and medical conditions of the 174 men and 248 women at baseline (W1, 2002) and follow up (W2, 2004). The mean age of the respondents was 79.9 years (standard deviation = 4.3 years).

Table 1. Descriptive Characteristics of the Study Subjects (N = 422)

Variable	Wave1		Wave2	
	n	%	n	%
Gender				
Male	174	41.2	—	
Female	248	58.8	—	
Age	79.9 ± 4.3 [†]		81.5 ± 4.3 [†]	
75 - 80	230	54.5	209	49.5
81 - 84	129	30.6	117	27.7
>_ 85	63	14.9	96	22.7
Living status				
Live with spouse	125	29.6	107	25.4
Live with others	236	55.9	244	57.8
Live alone	61	14.5	71	16.8
Long-term care services				
Support required	22	5.2	40	9.5
Care required	35	8.3	38	9.0
Medical conditions				
Hypertension	150	35.5	150	35.5
Diabetes mellitus	26	6.2	29	6.9
Cerebrovascular disease	11	2.6	13	3.1
Parkinson's disease	5	1.2	7	1.7
Arthritis	83	19.7	83	19.7
Hip fracture	38	9.0	38	9.0
Rheumatoid Arthritis	9	2.1	9	2.1
Visual disturbance	104	24.6	104	24.6
Respiratory disease	34	8.1	47	11.1

Note. Chi-square analyses showed that the proportional changes over time were not significant within the subjects in all variables.

[†]Mean ± SD.

Table 2. Descriptive Statistics Related to the Transition in ADL Ability and Mobility (N = 422)

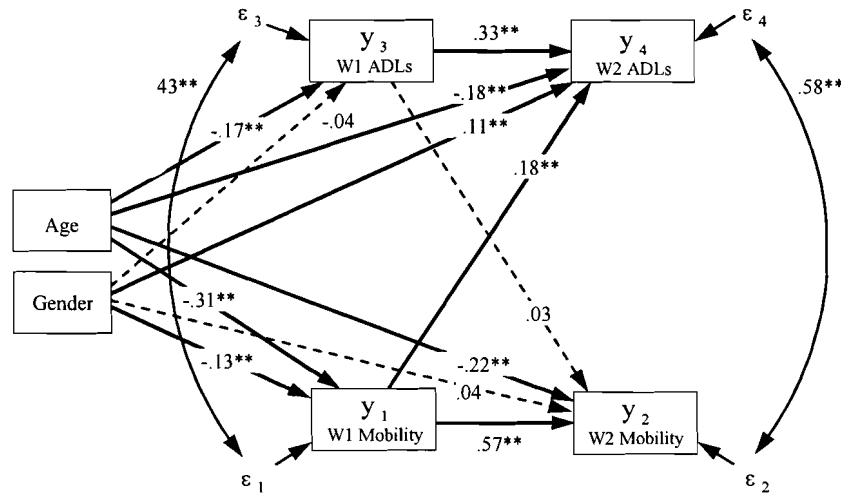
Variable	Wave1		Wave2		z	χ^2
	n [†]	%	n [†]	%		
Katz Index						
Score	5.8 ± 0.4 [‡]		5.7 ± 0.8 [‡]		-4.60	** [§]
Bathing	417	98.8	407	96.4		— ** [¶]
Dressing	418	99.1	405	96.0		— ** [¶]
Toileting	421	99.8	414	98.1		— * [¶]
Transferring	418	99.1	398	94.3		—
Continenence	370	87.7	355	84.1		84.95 **
Feeding	420	99.5	416	98.6		—
Rivermead Mobility Index						
Score	14.2 ± 1.4 [‡]		13.5 ± 2.7 [‡]		-6.64	** [§]
Turning over in bed	422	100	414	98.1		—
Lying to sitting	419	99.3	412	97.6		—
Sitting balance	422	100	409	96.9		—
Sitting to standing	420	99.5	397	94.1		—
Standing unsupported	406	96.2	392	92.9		46.33 **
Transfer	418	99.1	398	94.3		—
Walking inside with an aid if needed	422	100	403	95.5		—
Stairs	407	96.4	381	90.3		44.83 **
Walking outside (even ground)	407	96.4	374	88.6		— ** [¶]
Walking inside with no aid	409	96.9	377	89.3		— ** [¶]
Picking off floor	412	97.6	384	91.0		— ** [¶]
Walking outside (uneven ground)	364	86.3	356	84.4		126.79 **
Bathing	416	98.6	403	95.5		— ** [¶]
Up and down 4 steps	375	88.9	346	82.0		82.35 **
Running	272	64.5	250	59.2		124.27 **

Note. [†]The number of independent subjects. [‡]Mean ± SD.
[§]Wilcoxon's test. ^{||}Chi-square test. [¶]Fisher's exact probability test.
 * $p < .05$. ** $p < .01$.

Table 2 indicates the transition in ADL ability and mobility at W1 and W2. Statistical analyses using Wilcoxon's test showed declines on average in ADL ability and in mobility as assessed by the Katz index ($z = -4.60, p < .01$) and by the RMI ($z = 6.64, p < .01$). At W2, onset of new or recurrent disability in performance of ADLs was reported by 60 (14.2%) of the subjects and onset of new or recurrent mobility limitations was reported by 133 (31.5%) of the subjects. The Katz index showed declines in the level of independence in performing all items of ADLs except Transfer and Feeding. The RMI showed declines in mobility variables: standing unsupported, managing stairs, walking outside on even ground, walking inside with no aid, picking up something from the floor, walking outside over uneven ground, bathing, going up and down 4 steps with no rail, and running 10 m without limping.

CROSS-LAGGED STRUCTURAL EQUATION MODEL

The results of analysis using the cross-lagged structural equation model are shown in Figure 1. In terms of goodness-of-fit indices, there was an excellent fit of the model to the data: $\chi^2 = 3.047, p = .081; CFI = .997; TLI = .957; RMSEA = .070$ and $PCLOSE = .239$. The paths over time were high, with W1 ADLs predicting W2 ADLs ($\beta = .33, p < .01$) and W1 mobility predicting W2 mobility ($\beta = .57, p < .01$). In terms of cross-lagged effects, findings indicated that mobility significantly predicted an increase in ADL ability from the W1 to W2 ($\beta = .18, p < .01$). On the other hand, the path from ADLs at W1 to mobility at W2 was not significant ($\beta = .03, p = .468$). Age showed a significant negative association with ADL ability and mobility at W1 and W2, and gender showed a negative association with mo-



Note. The model, $\chi^2(1, N = 422) = 3.047, p = .081; CFI = .997; TLI = .957; RMSEA = .070$ and $PCLOSE = .239$. All parameter values are standardized. $y_1 - y_4$ = two variables measured 2 waves. $\epsilon_1 - \epsilon_4$ = factor variances. Full lines represent significant path coefficients and dotted lines represent non-significant path coefficients. ** $p < .01$. * $p < .05$.

Figure 1. Cross-lagged Structural Equation Model of ADL Ability and Mobility.

bility at W1 ($\beta = -.13, p < .01$) and a positive association with ADL ability at W2 ($\beta = .11, p < .01$).

ESTIMATING GROWTH OF ADL ABILITY AND MOBILITY

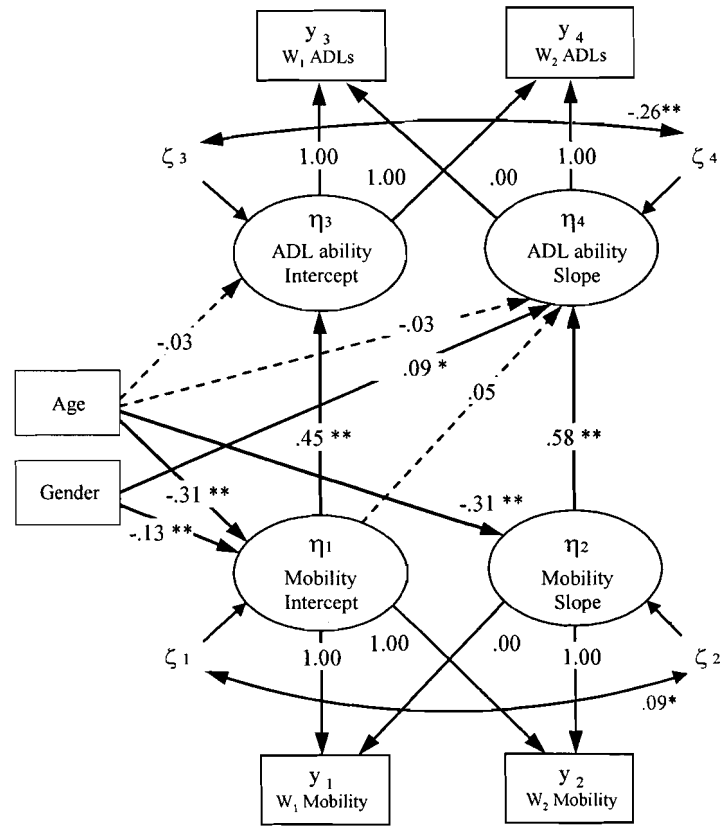
The results of analysis using the cross-lagged structural equation model indicated that mobility significantly predicted an increase in ADL ability from W1 to W2, but that ADL ability did not predict an increase in mobility. Thus, we tested a model in which latent factors representing intercept (initial status) and slope (rate of change) components for ADLs were predicted with latent factors representing intercept and slope components for mobility. The results are shown in Figure 2. In terms of goodness-of-fit indices, there was an excellent fit to the data ($\chi^2 = 4.534, p = .339; CFI = .999; TLI = .997; RMSEA = .018$ and $PCLOSE = .747$).

There were significant positive relationships between the path from the mobility intercept factor to the ADL ability intercept factor ($\beta = .45, p < .01$) and the path from the mobility slope factor to the

ADL ability slope factor ($\beta = .58, p < .01$). The path from the mobility intercept factor to the ADL ability slope factor was not significant ($\beta = .05, p = .207$). Thus, initially higher levels of mobility were associated with initially higher levels of performance of ADLs but not with changes over time in ADL ability. On the other hand, changes over time in mobility were associated with changes over time in ADL ability. As for control variables, gender had significant paths to the mobility intercept factor ($\beta = -.13, p < .05$) and the ADL ability slope factor ($\beta = .09, p < .05$). In contrast, age had no significant path to either the intercept and slope factor of ADL ability.

Discussion

In the present study, we investigated the longitudinal relationships between ADL ability and mobility in order to determine whether focusing on mobility of elderly people is an effective means for preventing reduction in ADL ability. The subjects of this study were residents of a town who were 75



Note. The model, $\chi^2(4, N = 422) = 4.534, p = .339; CFI = .999; TLI = .997; RMSEA = .018$ and $PCLOSE = .747$. All parameter values are standardized with the exception of the fixed factor loadings. Item uniquenesses were fixed to zero (0). η_1 and η_3 = initial status. η_2 and η_4 = rate of change. $y_1 - y_6$ = two variables measured 2 waves. $\zeta_1 - \zeta_4$ = factor variances. Full lines represent significant path coefficients and dotted lines represent non-significant path coefficients. ** $p < .01$. * $p < .05$.

Figure 2. Latent Growth Modeling of ADL Ability and Mobility.

years of age or older, and the follow-up interval was about 18 months. The age of the subjects and the follow-up interval were based on the results of previous epidemiological studies^{4,5,35} showing that ADL ability was reduced in about 10% of subjects aged 75 years or over and the results of several longitudinal studies showing that performance in mobility tests declined in a period of 18 months,²⁹⁻³¹ respectively. Since we excluded data obtained from participants with dementia and nonambulatory participants, all of the subjects used for analysis were ambulatory and had good cognitive function. However,

the scores for both ADL ability and mobility decreased significantly during the follow-up period for 14.2% and 31.5% of the subjects, respectively. These ratios are similar to previously reported ratios,^{4,29-31,35} indicating appropriate selection of subjects for testing of the longitudinal relationships between ADL ability and mobility.

In most previous longitudinal studies, it has been assumed that mobility affects ADL ability.^{5,14-17} The relationships between mobility at baseline and ADL ability at follow-up have also been investigated. However, it is known that mobility as well as

ADL ability decline with aging.²⁹⁻³¹⁾ According to the Disablement Process model,²⁸⁾ functional limitations cause disability and there are feedback effects of disability on functional limitations and functional impairment. In order to determine the longitudinal relationships, consideration must be given to the effect of ADL ability on future mobility. The results of our analysis showed that initial mobility affects future ADL ability and that initial ADL ability does not affect future mobility. Therefore, investigation of the relationships between mobility and ADL ability based on the assumption that mobility affects ADL ability seems appropriate.

Results of LGM analysis showed that the path from the mobility intercept factor to the ADL ability slope factor was not significant. On the other hand, the path from the mobility slope factor to the ADL ability slope factor was significant. These findings suggest that the initial level of mobility does not affect future ADL ability but that maintenance of the level of mobility will contribute to maintenance of ADL ability. The mean scores for both mobility and ADL ability were high at W1 and showed significant declines during the survey, although the magnitudes of declines in scores were not large. These distributions of scores for the subjects support that a decline in mobility affects a decline in ADL ability. Gender showed a significant positive relationship with the slope for ADLs and a significant negative relationship with the intercept for mobility. These findings mean that the initial level of mobility of female subjects is lower than that of male subjects, and that the female subjects more likely maintain ADL ability. In the previous studies, female subjects over 75 years old maintained levels of ADL ability more than did male subjects in the same age group,⁴⁾ but female subjects tended to show low levels of mobility compared with the male since the incidence of musculoskeletal dysfunctions such as arthritis was higher in women than in men.^{4,5)} Our result related to the slope for ADLs was same as the previous findings. Age showed significant relationships with both the intercept and slope for mobility but not with either the

intercept or slope for ADLs. Many previous studies have shown that aging is a factor causing decline in ADL ability.^{10,11)} According to the Disablement Process model,²⁸⁾ aging is more closely associated with mobility than with ADL ability. The results of the present study suggest that decline in ADL ability is caused by a decline in mobility.

We speculate that mobility is a target for preventing decline in the ability of elderly people to perform ADLs. Results of previous studies^{5,14-17)} using various methods of analysis have shown that subjects with higher levels of mobility at baseline had higher levels of ADL ability at follow-up. However, the present study showed that change in mobility rather than the initial level of mobility is associated with maintenance of ADL ability. The present study also revealed that mobility is more closely associated with aging than is ADL ability. This finding suggests that measures to prevent decline in mobility are important to prevent decline in the ability of elderly people to perform ADLs.

The present study has several limitations. One is that the survey was conducted in a rural area. Further studies using residents of urban areas are needed. Moreover, participants with dementia and nonambulatory participants were excluded from the subject population. Further study in which physical disability, health status, and psychosocial and environmental factors are controlled is needed to determine the effects of aging on mobility and performance of ADLs. Given that our subject was relatively high functioning at baseline, the question of the generalizability of our findings to the subgroup of less well functioning elderly people needs to be addressed. Another limitation of this study is the two-wave panel designs and short follow-up interval (18 months). Measurements at two time points bring the test of linear change, therefore a methodology of non-linear curve^{40,41)} is needed to depict time courses on competence of elderly people. Longer follow-up periods and more repeated measurements are needed to elucidate the relationships between ADL ability and mobility.

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