We observed functional transitions in instrumental activities of daily living (IADL) over one year among older Japanese and examined factors influencing the deterioration of each IADL. The sources of the study were the first and second panel studies of the Saku Longitudinal Study on Aging, which were done in 1988 and 1989. The study subjects were those participants aged 70 or older. Five IADL items - using public transportation, shopping for daily necessities, preparing meals, paying bills, and managing deposits - were measured in each survey. Deterioration of each IADL item was examined in relation to demographic characteristics such as age, sex, occupational status, living arrangements, and educational status. Of the effective baseline cohort (n = 5,559), 4,892 responded in the second survey (response rate 88%). Over 80% of the respondents who were initially independent in each IADL item remained independent in the second survey. Multiple logistic regression analyses revealed that greater age, having no occupation, and living with children at the baseline were associated with deterioration in each item of IADL. Lower educational status was associated with deterioration in each item of IADL except preparing meals. This study indicates that being engaged in work, living separately from children, and having higher educational status are strongly correlated with remaining independent in IADL for older people aged 70 or older.

INTRODUCTION

In 1984, the World Health Organization Scientific Group of the Epidemiology of Aging proposed the use of autonomy or independence in functioning as a health index for older people, in addition to mortality and morbidity. Conventionally, basic activities of daily living (BADL), such as dressing, eating, standing, and bathing, have been widely used to measure the physical functioning of older people. However, since BADL criteria were originally designed to measure the functioning of institutionalized people with physical disabilities, Lawton and Brody developed a scale for measuring instrumental activities of daily living (IADL), which includes the most relevant capacities to live independently in a community. Spector et al. hypothesized that disability in IADL would be a more sensitive predictor of functional decline and death than disability in BADL alone, due to its hierarchical relationship between BADL and IADL. Several studies showed that disability in IADL was associated with mortality among older people. Although the prevalence of IADL disability has been vigorously surveyed, only a few studies have examined factors associated with functional transitions in IADL, namely the Longitudinal Study on Aging (LSOA) and the Alameda County Study. To the best of our knowledge, there has been no study in Japan to examine such factors. We examined which socio-demographic factors were related to deterioration in each IADL item, with a one-year observation of a cohort of more than 6,000 older Japanese.

SUBJECTS AND METHODS

The sources of data for this study were the first and second
panel studies (in 1988 and 1989, respectively) of the Saku Longitudinal Study on Aging, which involved all the older residents of Saku City, Nagano Prefecture, Japan. The area is mainly agricultural and is located in the central mountainous district of the Japanese main island. Its latitude is about 700 meters above sea level. The city is divided into 127 small regions, and 540 health volunteers, called regional health volunteers, cooperate with the health department of the local government. The total population of the city in 1988 was 61,061.

The first survey was done in July 1988, involving the entire community of residents aged 60 or older of the city (N = 13,529) regarding their BADL, IADL, and their relevant characteristics such as age, sex, occupation, living with a spouse, living with children, and educational status. They were requested to participate in the survey and to fill out the questionnaire. BADL was measured using a modified Katz's ADL scale, which consisted of five items: bathing, dressing, using the toilet, standing, and eating. IADL was measured using the Tokyo Metropolitan Institute of Gerontology (TMIG) Index for Competency, which consisted of five items: using public transportation, shopping for daily necessities, preparing meals, paying bills, and managing deposits. The response to each item of the TMIG Index of Competence was designed simply as "yes" (able to do) or "no" (unable). The details of the surveys have been reported elsewhere.

Among the baseline cohort, we limited the subjects of this particular study to those who were aged 70 or older, because almost all of the subjects aged 60 to 69, independent in IADL in 1988, remained independent one year later. We also excluded those subjects who had any disability in BADL or were missing an item in 1988 or 1989, in order to minimize the effects of chronic medical conditions on IADL status.

We defined "functionally dependent subjects" as those reporting a loss of independence in each item of BADL or IADL. A comparison was made between people who were independent in each IADL item in both 1988 and 1989 and people who were independent in 1988 but dependent in 1989, using multiple logistic regression analysis.

**RESULTS**

In the first survey in 1988, we received questionnaires from 6,593 respondents aged 70 or older. Of those, 310 contained no data for various reasons such as nursing home institutionalization (n = 18), hospitalization (n = 17), death (n = 15), migration (n = 14), unable to answer due to physical disability (n = 5), or unknown reasons (n = 241). In addition, we excluded 559 subjects for their BADL dependence and 165 for their incompleteness of BADL items. Finally, we had 5,559 analyzable subjects at the baseline.

The second panel survey was conducted in July 1989. Of the baseline cohort of 5,559, 5,175 responded. However, 384 questionnaires contained no data due to death (n = 138), migration (n = 21), hospitalization (n = 20), nursing home institutionalization (n = 15), unable to answer due to physical disability (n = 2), or unknown reasons (n = 188). Therefore, the logistic regression analysis in this study was based on a total of 4,892 subjects, who accounted for 88.0% of the respondents in the baseline survey. There was no significant difference in sex between the respondents and non-respondents.

The average age of the subjects was 76.7 (±5.3) years (male = 40.0%). Table 1 shows subject characteristics at the time of the baseline survey. Table 2 shows the frequencies of independence in each IADL item by sex and age. Seventy-five percent of males and 66% of females were able to perform all IADL items at the time of the baseline survey. Preparing meals for males and using public transportation for females were shown to be the most difficult activities among the five items of IADL. The proportion of subjects reporting independence in each IADL item significantly decreased with advanced age.

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**Table 1. Characteristics of subjects at the time of the baseline survey, 1988.**

| Sex (female) | n=5,559 | % with condition present |
|-------------|---------|-------------------------|
| Age         | n=5,559 |                        |
| 70-74 years | 60.0    |                         |
| 75-79 years | 41.2    |                         |
| 80-84 years | 30.5    |                         |
| 85+ years   | 18.7    |                         |

Having occupation

| Having occupation | n=2,176 | % with condition present |
|-------------------|---------|-------------------------|
| male              | 73.8    |                         |
| female            | 52.5    |                         |

Living with a spouse

| Living with a spouse | n=2,931 | % with condition present |
|----------------------|---------|-------------------------|
| male                 | 49.2    |                         |
| female               | 66.9    |                         |

Living with children

| Living with children | n=3,315 | % with condition present |
|----------------------|---------|-------------------------|
| male                 | 75.2    |                         |
| female               | 22.8    |                         |

Educational status (9+years)

| Educational status (9+years) | n=2,221 | % with condition present |
|------------------------------|---------|-------------------------|
| male                         | 35.3    |                         |
| female                       | 22.8    |                         |
among males and females. Females were more likely to be
dependent on others to perform all IADL items than males,
except preparing meals.

Table 3-1 and 3-2 show the functional transitions in each
IADL item between 1988 and 1989 by gender and initial func-
tional status. Over 80% of the subjects remained at the same

| Using public transportation | Shopping for daily necessities | Preparing meals | Paying bills | Managing deposits |
|-----------------------------|-------------------------------|----------------|-------------|------------------|
| Age                         | Male (n=2,024) | Female (n=3,292) | Male (n=2,059) | Female (n=3,279) | Male (n=2,198) | Female (n=3,279) | Male (n=2,206) | Female (n=3,306) |
| 70-74                       | 96.6% (1,991) | 91.3% (3,239) | 97.6% (2,042) | 95.4% (3,227) | 89.5% (1,951) | 97.3% (3,239) | 97.1% (2,119) | 94.9% (3,233) |
| 75-79                       | 91.8% (1,929) | 78.5% (3,187) | 92.9% (2,010) | 88.3% (3,187) | 79.2% (1,929) | 90.3% (3,187) | 94.0% (2,120) | 87.5% (3,187) |
| 80-84                       | 82.1% (1,813) | 57.1% (3,116) | 85.0% (2,009) | 73.7% (3,106) | 66.8% (1,813) | 78.4% (3,116) | 89.2% (2,112) | 77.5% (3,116) |
| 85+                         | 58.9% (1,217) | 30.5% (1,012) | 63.8% (1,265) | 51.9% (1,012) | 38.8% (1,217) | 55.0% (1,012) | 74.0% (1,265) | 55.7% (1,012) |
| Total                       | 89.4% (1,797) | 74.7% (1,191) | 91.1% (1,937) | 84.6% (1,191) | 78.0% (1,797) | 87.2% (1,191) | 92.8% (1,937) | 85.2% (1,191) |

Mantel-Haenszel
chi-square++

* : p<.05, ** : p<.01, *** : p<.001
+ : Comparison of proportion of subjects who were independent in each item of IADL between male and female in each age group.
++ : Comparison of proportion of subjects who were independent in each item of IADL between male and female among all age groups.

Table 3-1. Functional transitions in each item of instrumental activities of daily living (IADL) one year later among subjects who were
initially independent in all IADL items, 1988-1989.

| Item                  | independent in IADL and BADL | dependent in IADL and independent in BADL | dependent in both IADL and BADL | dead | no reply | total |
|-----------------------|-----------------------------|------------------------------------------|---------------------------------|-------|----------|-------|
| Using public transportation |                            |                                          |                                 |       |          |       |
| Male                  | % 87.5                     | 4.7                                      | 1.3                             | 2.4   | 4.1      | 100.0 |
|                       | N 1,681                     | 91                                       | 25                              | 46    | 78       | 1921  |
|                       | Female                    | % 86.3                                   | 7.6                             | 0.9   | 1.0      | 100.0 |
|                       | N 2,057                     | 7.6                                      | 21                              | 1.0   | 4.3      | 2384  |
| Shopping for daily necessities |                            |                                          |                                 |       |          |       |
| Male                  | % 88.4                     | 3.5                                      | 1.4                             | 2.7   | 4.1      | 100.0 |
|                       | N 1,730                     | 68                                       | 27                              | 52    | 81       | 1958  |
|                       | Female                    | % 87.6                                   | 5.3                             | 1.3   | 1.3      | 100.0 |
|                       | N 2,372                     | 53                                       | 27                              | 1.3   | 4.5      | 2707  |
| Preparing meals       |                            |                                          |                                 |       |          |       |
| Male                  | % 83.3                     | 9.0                                      | 1.2                             | 2.0   | 4.5      | 100.0 |
|                       | N 1,358                     | 147                                      | 19                              | 3.3   | 73       | 1630  |
|                       | Female                    | % 87.4                                   | 5.5                             | 1.3   | 1.3      | 100.0 |
|                       | N 2,430                     | 152                                      | 37                              | 1.3   | 4.5      | 2781  |
| Paying bills          |                            |                                          |                                 |       |          |       |
| Male                  | % 89.4                     | 2.4                                      | 1.3                             | 2.6   | 4.3      | 100.0 |
|                       | N 1,769                     | 47                                       | 25                              | 2.6   | 4.3      | 1978  |
|                       | Female                    | % 86.9                                   | 5.9                             | 1.4   | 1.4      | 100.0 |
|                       | N 2,347                     | 5.9                                      | 1.4                             | 1.4   | 4.5      | 2701  |
| Managing deposits     |                            |                                          |                                 |       |          |       |
| Male                  | % 87.7                     | 3.8                                      | 1.4                             | 2.8   | 4.3      | 100.0 |
|                       | N 1,734                     | 76                                       | 28                              | 5.5   | 85       | 1978  |
|                       | Female                    | % 85.5                                   | 7.9                             | 1.3   | 1.1      | 100.0 |
|                       | N 2,110                     | 194                                      | 31                              | 1.1   | 4.3      | 2469  |
| All items of IADL     |                            |                                          |                                 |       |          |       |
| Male                  | % 82.8                     | 9.9                                      | 1.0                             | 2.0   | 4.3      | 100.0 |
|                       | N 1,270                     | 151                                      | 16                              | 2.0   | 4.3      | 1533  |
|                       | Female                    | % 84.4                                   | 9.8                             | 0.8   | 0.8      | 100.0 |
|                       | N 1,701                     | 197                                      | 16                              | 1.7   | 4.2      | 2016  |
Table 3-2. Functional transitions in each item of instrumental activities of daily living (IADL) one year later among subjects who were initially dependent in any IADL item, 1988-1989.

| Item                         | independent in IADL and BADL | dependent in IADL and independent in BADL | dependent in both IADL and BADL | dead | no reply | total |
|------------------------------|------------------------------|-------------------------------------------|--------------------------------|------|----------|-------|
| Using public transportation  | male % 18.6 N 42             | 14.2                                      | 10.2                           | 8.0  | 18       | 226   |
|                              | female % 17.1 N 136         | 9.3                                       | 5.4                            | 5.5  | 43       | 796   |
| Shopping for daily necessities| male % 25.8 N 49             | 16.3                                      | 10.0                           | 7.9  | 19       | 190   |
|                              | female % 23.2 N 113         | 11.5                                      | 6.2                            | 5.3  | 30       | 487   |
| Preparing meals              | male % 31.4 N 142           | 9.1                                       | 8.2                            | 4.9  | 37       | 453   |
|                              | female % 21.8 N 88          | 11.9                                      | 7.4                            | 5.2  | 48       | 403   |
| Paying bills                 | male % 33.3 N 51            | 17.7                                      | 10.5                           | 6.5  | 16       | 153   |
|                              | female % 36.2 N 170         | 9.4                                       | 6.4                            | 5.3  | 44       | 470   |
| Managing deposits            | male % 16.7 N 28            | 16.7                                      | 9.5                            | 6.6  | 28       | 168   |
|                              | female % 18.6 N 137         | 8.6                                       | 5.4                            | 5.4  | 40       | 735   |
| All items of IADL           | male % 27.5 N 138           | 8.8                                       | 7.2                            | 5.6  | 36       | 501   |
|                              | female % 18.0 N 185         | 7.2                                       | 4.8                            | 5.5  | 49       | 57    |

level as they reported at the time of the baseline survey. During the one-year interval, for each IADL item, four to seven percent of subjects who were initially independent became dependent. With the exception of preparing meals, males were more likely to remain independent in each IADL item than females. On the other hand for each IADL item, among respondents who were initially dependent, from 17% (using public transportation) to 36% (paying bills) had improved and become independent at the time of the second survey. Table 4 shows factors influencing functional deterioration in IADL, based on the results of multiple logistic regression analyses. A comparison was made between people who were independent in each IADL item in both 1988 and 1989 and people who were independent in 1988, but dependent in 1989. It was found that greater age, having no occupation, and living with children at the time of the baseline survey were associated with a functional decline in any IADL item after adjusting for the effects of gender and living with a spouse. In addition, lower educational status was associated with deterioration in all IADL items, except preparing meals.

**DISCUSSION**

We examined functional transitions in IADL over one year and the factors influencing the transitions among older Japanese living in a rural district. When we examined IADL transitions and factors influencing these transitions, we focused on each IADL item separately, instead of summing up all of the items in this study, because the importance of each item varies greatly among individuals. Our study revealed that the majority of subjects who were initially independent in each IADL item maintained the same functional status one year later. Multiple logistic regression analyses revealed that lower age, being engaged in work, and living separately from children at the time of the baseline survey were strongly correlated with remaining independent in all IADL items among older people. We suggest that it is important for older people to accomplish IADL by themselves and be engaged in work in order to sustain their functional independence.
Table 4. Results of multiple logistic regression analyses predicting functional decline between 1988 and 1989 among those who were initially independent in each item of instrumental activity of daily living (IADL) *.

|                  | Using public transportation | Shopping for daily necessities | Preparing meals | Paying bills | Managing deposits |
|------------------|-----------------------------|-------------------------------|----------------|-------------|-------------------|
|                  | OR  | 95% CI | p value | OR  | 95% CI | p value | OR  | 95% CI | p value | OR  | 95% CI | p value |
| Age 70-79        | 1.00 | 1.00 |              | 1.00 | 1.00 |              | 1.00 | 1.00 |              | 1.00 | 1.00 |              |
| Age 80+          | 3.12 | 2.39 | 4.08 <0.001 | 3.31 | 2.49 | 4.40 <0.001 | 2.84 | 2.19 | 3.68 <0.001 | 3.18 | 2.37 | 4.25 <0.001 |
| Sex male         | 1.00 | 1.00 |              | 1.00 | 1.00 |              | 1.00 | 1.00 |              | 1.00 | 1.00 |              |
| Sex female       | 1.24 | 0.94 | 1.64 0.127 | 0.91 | 0.67 | 1.23 0.535 | 0.42 | 0.32 | 0.55 <0.001 | 1.50 | 1.08 | 2.07 0.015 |
| Having occupation yes | 1.00 | 1.00 |              | 1.00 | 1.00 |              | 1.00 | 1.00 |              | 1.00 | 1.00 |              |
| Having occupation no | 2.05 | 1.57 | 2.66 <0.001 | 2.84 | 2.13 | 3.79 <0.001 | 2.13 | 1.63 | 2.78 <0.001 | 1.92 | 1.43 | 2.57 <0.001 |
| Living with spouse yes | 1.00 | 1.00 |              | 1.00 | 1.00 |              | 1.00 | 1.00 |              | 1.00 | 1.00 |              |
| Living with spouse no | 0.85 | 0.64 | 1.13 0.273 | 1.09 | 0.81 | 1.47 0.579 | 0.96 | 0.73 | 1.27 0.795 | 1.00 | 0.74 | 1.36 0.987 |
| Living with children yes | 1.49 | 1.11 | 2.01 0.008 | 2.02 | 1.42 | 2.87 <0.001 | 2.26 | 1.66 | 3.07 <0.001 | 2.20 | 1.51 | 3.21 <0.001 |
| Educational status 9+years | 1.00 | 1.00 |              | 1.00 | 1.00 |              | 1.00 | 1.00 |              | 1.00 | 1.00 |              |
| Educational status 0-8years | 1.94 | 1.42 | 2.65 <0.001 | 1.52 | 1.08 | 2.14 0.016 | 1.15 | 0.87 | 1.52 0.320 | 1.98 | 1.36 | 2.87 <0.001 |

N 3,610 3,886 3,671 3,921 3,704

**chi-square** 9.81 (p=0.28) 5.65(p=0.69) 9.83 (p=0.28) 4.08 (p=0.85) 5.76 (p=0.67)

* : The reference group consisted of those subjects who were independent in IADL in both 1988 and 1989. Functional decline denotes those subjects who were independent in 1988 but dependent in 1989. OR and 95% CI denote odds ratio and 95% confidence interval, respectively.

This study indicates that being engaged in work may contribute to remaining independent in all IADL items for functionally independent older people. Among the subjects in this study, 74% of males and 53% of females were engaged in work even after age 70, and 70% of them were engaged in agricultural work. As it was reported that being engaged in work was protective against functional declines in BADL or IADL using data from the LSOA 7,8), we also consider that physical activity during work may be effective in maintaining independence in IADL among older Japanese aged 70 or more.

The present study also revealed that living with children was associated with a deterioration in all IADL items among older subjects. One possible explanation for this result is that some Japanese parents tend to rely on their children for assistance with IADL and thereby lose their independence. Japanese children often help their elderly parents with IADL due to the traditional Japanese social norm that children should look after their parents. Seeman et al. 17) also reported the negative effects of receiving excessive instrumental support on physical performance among older people, based on the results of the MacArthur Studies of Successful Aging. Another explanation is that our study may not be able to detect the potential disabilities of those older people living with their children. To examine the second possibility, further study should be conducted to identify the reasons why older people live with their children.

When interpreting the results of our study, some limitations must be considered. First, even if a highly reliable questionnaire is used to assess functional status, a substantial proportion of subjects who are assessed as dependent in an IADL item based on the questionnaire are incorrectly labeled as independent when a less frequent event is examined using questionnaires. For example, suppose that a questionnaire with 95% test-retest reliability is used to observe an IADL item, and 5,000 analyzable respondents are obtained. Assuming that the true proportion of independence in the item among the respondents is 90%, the total number of subjects who are independent in the item is 4,300 (= 5,000 * 0.95 * 0.9 + 5,000 * 0.05 * 0.1 = 4,275 + 25), and the total number of subjects who are dependent in the same item is 700 (= 5,000 * 0.05 * 0.9 + 5,000 * 0.95 * 0.1 = 225 + 475). Whereas 99% (4,275/4,300) of subjects who gave the answer "independent" for the item are correctly labeled as independent, only 68% (475/700) of subjects who gave the answer "dependent" for the item are correctly labeled as dependent.

Second, the reliability and validity of self-reported measures of function among the elderly should be examined. As regards the methodology used in this study, the questionnaire was printed in large type and contained few questions. We found that the test-retest reliability of the BADL and IADL scales used in this study was generally good 18). In addition, we consider that the scales were adequately valid, because the distributions of BADL and IADL among the entire sample in this study were similar to those for studies conducted in other areas of Japan 19). Therefore, we believe that this study identified...
functional deterioration using reliable and valid scales. Finally, we used multiple logistic regression analyses to control the effects of the potential confounding factors among demographic variables when we examined factors influencing functional transitions. However, there might be other residual confounding factors. Some researchers reported that medical conditions were associated with functional status but others reported negative results in this regard. In order to control the effect of chronic medical conditions on physical function, we restricted the subjects in this study to participants who had no disabilities in BADL items in either the baseline or the second survey. In addition, other physical functions, which were not measured in this study, may be residual confounding factors.

The Japanese government has monitored health status indicators such as mortality and morbidity for various diseases among older people. However, functional status and its transition have rarely been measured. In order to assess the various requirements among elderly people in a community and provide appropriate health services, measurement of various aspects of functional competence, such as BADL, IADL, and intellectual activity, is essential. Such information is also important in order to prevent functional deterioration of older people living in communities.

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