
Functional status and active life expectancy among senior citizens in a small town in Japan

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Abstract

The objectives of this study were to understand transition patterns and mechanisms of functional status, and to estimate active life expectancy (ALE) among senior citizens in a small town in Japan. With data drawn from surveys conducted annually from 1998 to 2002 (n = 638 at baseline), prevalence and incidence of functional disability in activities of daily living (ADL) and instrumental activities of daily living (IADL) were described and compared between the sexes. Then relationships between potential predictors and functional decline through a 4-year follow-up were examined using logistic regression. Finally, active and disabled life expectancy was estimated by Katz’s method. At baseline, 9 and 12% of subjects were dependent in performing ADL and IADL, respectively. Prevalence and incidence rates increased with age. The risk of mortality increased by 2.2–5.0-fold when the subject was functionally dependent at the previous year. Advanced age, difficulty in walking and poor interest were shown to be significant predictors of loss of independence in ADL. Mean durations with disability in ADL and IADL among women were longer than among men by around 1 year. Population-specific preventive care programs considering physical, cognitive and social aspects are needed not only to maximize ALE but also to improve quality of life during survival period with disability especially in old women.

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Keywords: Active life expectancy; Activities of daily living; Longitudinal study; Preventive care; Senior citizens; Sex difference

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1. Introduction

The more the population in an area ages, the more significant not only quantity but also quality of life becomes. Physical performance, which largely determines quality of life, can be assessed by activities of daily living (ADL) and instrumental activities of daily living (IADL). By regarding disabilities in ADL as a functional loss, Katz et al. (1983) proposed active life expectancy (ALE), which represents the expected duration of functional independence in ADL. To date, ALE has been estimated in various studies to measure health status of the population (Branch et al., 1991; Liu et al., 1995; Tsuji et al., 1995; Sauvaget et al., 1999; Ishizaki et al., 2002). Recently, ALE which was measured not only by ADL but also IADL (Ishizaki et al., 2002), and IADL plus mobility function (Sauvaget et al., 1999) has been reported considering the hierarchical decline in functional performance (Katz et al., 1983; Spector et al., 1987). Sauvaget et al. (1999) suggested that men develop functional disability earlier and more rapidly than women. In other words, women, with longer total life expectancy (TLE) than men, are expected to spend a longer duration with functional difficulty than men (Strawbridge et al., 1992). On the other hand, Stuck et al. (1999) reviewed predictors of functional decline, among which chronological age, cognitive impairment, co-morbidity, depression, low frequency of social contact, low physical activity, low physical performance, poor self-perceived health and vision impairment were reported to have strong association.

The results of previous studies generally note how to prevent or delay the onset of functional decline among senior citizens in terms of public health. However, with such information, we cannot establish appropriate preventive care measures, which depend on specific characteristics of the population. In Japan, since the Public Insurance for Long-term Care was introduced in 2000, local governments have been required to provide adequate measures based on such specific information towards successful aging of the community population. Some municipalities launched regular population-based surveys as part of comprehensive care programs for senior citizens. But it is difficult for them, with limited resources, to routinely assess each factor of the residents using special indices like many scientific studies do. In many cases, they alternatively used relatively simple methods such as questionnaires to assess the primary prevention methods.

As the longitudinal surveys we used here, despite a small sample, had high coverage rates, the characteristics of the whole residents can be readily ascertained. For example, sex differences in ALE and the transition patterns of functional status will help us understand the background and intervene sex- and age-specific approaches toward successful aging.

Here we describe transition patterns and mechanisms of functional status, using the data from surveys annually conducted in a small town in Hokkaido, Japan, and estimate predictors of functional decline. Then the difference in duration with functional difficulty between the sexes is discussed in the context of more effective preventive care programs.
2. Methods

2.1. Data collection

Five consecutive annual surveys on preventive care for senior citizens were carried out in Minami Furano Town, Hokkaido, Japan, from 1998. The study target subjects were all the senior citizens aged 65 or over in the town. At the baseline survey in 1998, trained community health volunteers interviewed the subjects with a standardized structured questionnaire including items on demographic characteristics, the ability to perform ADL and IADL, dementia and self-reported health status.

There were 705 elderly residents aged 65 years or older in 1998 and 51 were in a nursing home. Among the remaining 654 non-institutionalized resident’s, completed interviews were obtained from 638 subjects (90.5% of all the residents aged 65 years or older). The follow-up surveys were carried out annually in the same way until 2002.

2.2. Functional status

Functional status was self-reported at baseline and follow-up surveys. The functional status was considered to have two hierarchical levels of activities: basic ADL and higher IADL. ADL was measured using a modified Katz’s ADL scale, consisting of five items: bathing, dressing, toileting, standing, and eating (Katz et al., 1983). IADL included five activities: using the telephone, managing heat for cooking, using public transportation, taking medication, and handling finances (Japanese association of certified social workers, 2000).

The subjects were classified as ADL- or IADL-independent when they reported being able to perform all the activities of ADL or IADL without difficulties, respectively. Those who reported that they needed assistance in or could not perform at least one task were defined as dependent.

2.3. Data analysis

Functional decline was defined as transition to dependent during the 1-year follow-up period among those who had been independent the previous year. Recovery refers to becoming independent during the 1-year follow-up period among those who had been dependent 1 year before. Prevalence rates of functional dependence were calculated from the data obtained at the baseline survey in 1998. For incidence rates of functional decline, functional transitions from 1 year to the next through 1998–2002 were calculated by the person-years method. In comparing rates between the sexes, the indirect standardized rate ratio (SRR) method was used.

The relationship between the functional level in the previous survey and mortality was examined using the Cox proportional hazards model (Cox, 1972) adjusted for age.

Then functional transitions in 4 years were examined. When the subjects who were independent at the baseline died or became dependent or institutionalized by 2002, these transitions were defined as loss of independence. We used logistic regression models and examined the relationship between potential predictors at the baseline as independent
variables and loss of independence as a dependent variable. Crude odds ratios (OR) with 95% confidence intervals for the loss of independence were estimated for the following predictors: sex, age, ability to walk, screening items for dementia (memory, disorientation and interest), vision, hearing. Here self-rated health was not analyzed because the questionnaire, which included objective health status, "being treated", did not represent his or her subjective health status. To examine the independence of the relationship, adjusted ORs were calculated including all the significant ($P < 0.10$ on the Wald test) variables associated with loss of independence in the unadjusted regression analysis.

For the estimation of ALE, a modified Branch’s method (Branch et al., 1991) was used, considering transitions from independent to dependent and from independent to deceased. Incidence of recovery from dependent to independent was not counted because of low numbers. The sum of the incidence rates of the two transitions was used to make life tables instead of mortality rates. TLE was calculated from municipal death data based on death certificates. At the ages of 90 years or older, occurrences were combined because of a lack of observed cases. Coverage rates of the surveys decreased at older age groups, especially for women because of their institutionalization. To minimize underestimation of functionally disabled life expectancy, the institutionalized elderly were considered as dependent both in ADL and IADL (Hing and Bloom, 1990; Ishizaki et al., 2002). Because the observed probabilities were unsteady due to a small sample size, a smoothing method with the Poisson log-linear regression was used. In this method, sex- and age-specific rates for mortality and incidence of functional dependence were estimated by age, an independent variable. All the models well fitted the data assessed by Pearson’s Chi-squared statistics and all regression coefficients were significant ($P < 0.0001$) in each model.

All statistical tests were performed with an SAS statistical package version 8.2 (SAS Institute Inc., Cary, NC).

3. Results

3.1. Study sample

Of the 654 community-dwelling senior citizens aged 65 years or older, 638 people (97.6%; 313 men and 325 women; mean age: 74.0 years; age ranges 65–93 years; S.D.: 6.15 years) were assessed at baseline. There was no statistically significant difference in demographic characteristics between these subjects and those who were not assessed.

3.2. Prevalence of dependence and incidence of functional decline

Table 1 shows the prevalence of functional dependence and incidence rates of functional decline according to sex and age group. At the baseline, 55 (8.6%) subjects were dependent in ADL and 78 (12.2%) in IADL. The prevalence of disability increased with aging in both ADL and IADL, especially among those aged 85 years or older. Among the five ADL items, the overall prevalence ranked as follows: bathing (5.5%), standing (4.9%), dressing (2.8%), toileting (2.4%) and eating (1.4%). In men, the order was same as that of the total
Table 1
Age- and sex-specific prevalence rate (per 100 persons) of functional dependence at the baseline (1998) and incidence rate (per 100 person-years) of functional decline (1998–2002), Minami Furano Town

<table>
<thead>
<tr>
<th>Sex</th>
<th>Age group</th>
<th>n</th>
<th>ADL Prevalence</th>
<th>ADL Incidence</th>
<th>IADL Prevalence</th>
<th>IADL Incidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males</td>
<td>65–74</td>
<td>221</td>
<td>5.0</td>
<td>0.9</td>
<td>9.0</td>
<td>1.3</td>
</tr>
<tr>
<td></td>
<td>75–84</td>
<td>77</td>
<td>7.8</td>
<td>2.7</td>
<td>13.0</td>
<td>2.5</td>
</tr>
<tr>
<td></td>
<td>85+</td>
<td>15</td>
<td>20.0</td>
<td>4.5</td>
<td>26.7</td>
<td>14.7</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>313</td>
<td>6.4</td>
<td>1.6</td>
<td>10.9</td>
<td>2.3</td>
</tr>
<tr>
<td>Females</td>
<td>65–74</td>
<td>204</td>
<td>7.8</td>
<td>0.5</td>
<td>5.9</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>75–84</td>
<td>99</td>
<td>12.1</td>
<td>2.8</td>
<td>22.2</td>
<td>4.5</td>
</tr>
<tr>
<td></td>
<td>85+</td>
<td>22</td>
<td>31.8</td>
<td>7.2</td>
<td>45.5</td>
<td>13.0</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>325</td>
<td>10.8</td>
<td>1.7</td>
<td>13.5</td>
<td>2.6</td>
</tr>
</tbody>
</table>

Standardized rate ratio, M/F 0.64 1.03 0.92 0.87
95% Confidence interval 0.36–0.91 0.58–1.49 0.61–1.23 0.54–1.20

population. Women had the highest prevalence of dependence in standing followed by bathing. For IADL, using public transportation (8.9%), using the telephone (6.0%), taking medication (5.5%), handling finances (5.0%) and managing heat for cooking (4.4%). While taking medication was the easiest task in men, it was the second highest prevalence next to using public transportation in women. Similar trends were observed throughout follow-up years. Incidence rates of functional decline in performing ADL among men and women were 1.6 and 1.7, respectively. In IADL performance, incidence rates of 2.3 and 2.6 for men and women were observed. As observed for prevalence, the incidence of functional decline also increased with age.

Prevalence rates in ADL were significantly lower in men than in women (SRR = 0.64, 95% CI = 0.36–0.91). There was no statistically significant sex difference in any other prevalence rates or incidence rates.

3.3. Mortality and recovery rates

The overall mortality rate was 2.7 per 100 person-years. The difference in mortality rates between the sexes was not statistically significant (SRR = 1.08, 95% CI = 0.71–1.45).

The relative hazards for mortality according to sex and functional status in the previous year are shown in Table 2. The relative hazards adjusted for age were all statistically significant. The risk of mortality increased by 2.2–5.0-fold when the subject was functionally dependent at the previous year. A man who had been dependent in ADL was five times more likely to die in the next year than one who had been independent. Among women, this risk was nearly three times higher.

Overall recovery rates were 4.0 and 3.3 per 100 person-years for ADL and IADL, respectively. Recovery rates compared between the sexes were lower in men (SRR = 0.90 for ADL and 0.77 for IADL), but neither of them was statistically significant.
### Table 2
Relationship between mortality and functional status at the previous year, estimated by Cox proportional hazards model adjusted for age, Minami Furano Town (1998–2002)

<table>
<thead>
<tr>
<th>Functional status at the previous year</th>
<th>Male RH (95% CI)</th>
<th>Female RH (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dependent</td>
<td>5.02 (2.33–10.83)</td>
<td>2.82 (1.43–5.56)</td>
</tr>
<tr>
<td>Independent</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>IADL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dependent</td>
<td>2.25 (1.02–4.96)</td>
<td>2.23 (1.06–4.67)</td>
</tr>
<tr>
<td>Independent</td>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

* RH (95% CI): relative hazard and 95% confidence interval.

### 3.4. Predictors of loss of independence during the 4-year follow-up

After excluding 33 people who were missing from the follow-up surveys, predictors of loss of independence were examined. No significant difference was found in demographic characteristics or functional status at baseline between those who were missing and those who were not. Among 553 and 531 people who were independent at the baseline, 71 (12.8%) and 83 (15.6%) lost their independence in ADL and IADL performance, respectively.

Table 3 shows the relationship between loss of independence in ADL and IADL performance and potential predictors. Advanced age and difficulty in walking were shown to be significant predictors of losing independence both in ADL and IADL performance, respectively.

The adjusted analysis, all three factors were independently associated with loss of independence in ADL performance, while difficulty in walking and poor interest were significant predictive factors of losing independence in IADL.

### 3.5. Patterns of ALE free from difficulty in ADL and IADL

Total and functional life expectancies assessed by ADL and IADL for each sex is shown in Table 4. At the age of 65, TLE in men is 20.2 years. After spending 17.5 years without any functional difficulties, they become dependent only in IADL for 1.2 years and then become dependent in both ADL and IADL for the rest of TLE, 1.5 years. TLE among women was longer than among men. On the other hand, at the ages of 70 years or older, ALE among men is longer than among women both in ADL and IADL.

Fig. 1 shows the mean duration when an elderly person is expected to be functionally dependent in ADL and IADL by sex. Men are expected to experience a shorter period with difficulty in ADL and IADL than women. While men aged 73 years or older spend less than 1 year with ADL disability, women have nearly 2 years at the age of 75 years old. The difference between the period with IADL difficulty and that with ADL difficulty, which means the duration only with IADL disability but free from dependence in ADL, is 1.2 and 0.7 years among men and 1.6 and 0.9 years among women at 65 and 85 years old, respectively.
### Table 3
Odds ratio (OR) and 95% confidence interval (CI) of factors potentially predicting the loss of independence in ADL and IADL performance through the 4-year follow-up, Minami Furano Town (1998–2002)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Loss of independence in ADL performance (71/553)</th>
<th>Loss of independence in IADL performance (83/531)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Subject</td>
<td>Crude OR (95% CI)</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>37/275</td>
<td>1.00</td>
</tr>
<tr>
<td>Male</td>
<td>34/278</td>
<td>0.90 (0.54–1.48)</td>
</tr>
<tr>
<td>Age at baseline</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;75</td>
<td>42/400</td>
<td>1.00</td>
</tr>
<tr>
<td>≥75</td>
<td>29/153</td>
<td>1.99 (1.19–3.34)</td>
</tr>
<tr>
<td>Difficulty in walking</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>59/516</td>
<td>1.00</td>
</tr>
<tr>
<td>Yes</td>
<td>12/37</td>
<td>3.72 (1.78–7.80)</td>
</tr>
<tr>
<td>Memory</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Good</td>
<td>63/518</td>
<td>1.00</td>
</tr>
<tr>
<td>Impaired</td>
<td>8/35</td>
<td>2.14 (0.93–4.92)</td>
</tr>
<tr>
<td>Disorientation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>68/540</td>
<td>1.00</td>
</tr>
<tr>
<td>Yes</td>
<td>3/13</td>
<td>2.08 (0.56–7.76)</td>
</tr>
<tr>
<td>Interest</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Well</td>
<td>54/491</td>
<td>1.00</td>
</tr>
<tr>
<td>Poor</td>
<td>17/62</td>
<td>3.06 (1.64–5.72)</td>
</tr>
<tr>
<td>Hearing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Good</td>
<td>61/460</td>
<td>1.00</td>
</tr>
<tr>
<td>Impaired</td>
<td>10/93</td>
<td>0.82 (0.41–1.68)</td>
</tr>
<tr>
<td>Vision</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Good</td>
<td>59/468</td>
<td>1.00</td>
</tr>
<tr>
<td>Impaired</td>
<td>12/85</td>
<td>1.64 (1.52–2.08)</td>
</tr>
</tbody>
</table>

* Adjusted for all other variables significant at \( P < 0.10 \) on unadjusted logistic regression (Wald test).

### 4. Discussion

#### 4.1. Sex-specific prevalence, incidence and mortality

Our result that prevalence of functional dependence in ADL was higher in women than in men was consistent with some studies (Leveille et al., 2000; Ishizaki et al., 2002) but not with others (Sauvaget et al., 1999). Leveille et al. (2000) reported that higher prevalence of mobility disability in women than in men is mainly attributed to higher incidence rates. That is, while women are likely to suffer from chronic or slow-growing diseases such
as rheumatoid arthritis, men tend to develop acute conditions such as cardiovascular disease. However, we found no significant difference in incidence between the sexes. Further observation is needed because the survey population in our study is small.

Among women aged between 65 and 74, was observed a higher prevalence of difficulty in IADL performance than in ADL, which is inconsistent with the hierarchical relationship between ADL and IADL. This discrepancy is partly because of the difference in the items used to measure ADL performance. While many other studies used four items: bathing, dressing, eating and transferring from bed to chair, we included standing and toileting instead of transferring. Standing was the most difficult task for women, which may be due

### Table 4

Total life expectancy (TLE), functionally active and disabled life expectancy in ADL and IADL performance by age and sex, Minami Furano Town (1998–2002)

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TLE</td>
<td>ADL</td>
</tr>
<tr>
<td></td>
<td>Active</td>
<td>Disabled</td>
</tr>
<tr>
<td>65</td>
<td>20.2</td>
<td>18.7</td>
</tr>
<tr>
<td>70</td>
<td>16.1</td>
<td>14.9</td>
</tr>
<tr>
<td>75</td>
<td>12.3</td>
<td>11.5</td>
</tr>
<tr>
<td>80</td>
<td>9.1</td>
<td>8.5</td>
</tr>
<tr>
<td>85</td>
<td>6.3</td>
<td>5.8</td>
</tr>
</tbody>
</table>

![Fig. 1. Sex-specific mean duration with functional disability in ADL and IADL, Minami Furano Town (1998–2002).](image)
to the generally observed higher prevalence of musculoskeletal disorders in women than in men, but such etiological character is to be confirmed in future surveys.

Dependence in ADL raised mortality risk (Table 2). This finding is consistent with that of Guralnik et al. (1991), who reported that most deceased persons had lost their functional independence in the year prior to death. Although ADL-disabled men presented no significantly higher mortality rate compared with women (standardized mortality ratio = 1.94, 95% CI = 0.86–4.39) partly due to the small number of deaths, the relative hazard of ADL disability for mortality was higher in men than in women. Our results are consistent with other studies reporting that men with disabilities are more likely to die than women (Strawbridge et al., 1992; Sauvaget et al., 1999). Because deceased persons are not included in counting prevalence either as denominator or numerator, prevalence of disability tends to decrease as disabled men die and leave the population earlier. The sex-specific mortality pattern can partly explain the difference in prevalence of disability.

4.2. Predictors of loss of independence

Of the potential predictors measured, three factors showed significant relationships: ages of 75 or older, difficulty in walking and poor interest.

Advanced age for ADL disability, is consistent with other studies (Guralnik et al., 1993; Kaplan et al., 1993; Mor et al., 1994; Seeman et al., 1994; Beland and Zunzunegui, 1999; Ishizaki et al., 2000). While for IADL disability, the age of 75 or older was a borderline risk factor, which may reflect earlier onset of difficulty in IADL performance than that in ADL disability.

A number of studies reported that factors related with walking such as mobility impairment (Guralnik et al., 1993) lower-extremity joint impairment (Dunlop et al., 1998), impaired lower-extremity function (Guralnik et al., 1995) and habit of walking (Strawbridge et al., 1996; Ishizaki et al., 2000; Fujisawa et al., 2003) were associated with functional decline. Walking speed was also identified as a predictor (Judge et al., 1996; Woo et al., 1999; Shinkai et al., 2000). High mobility was shown to predict recovery in ADL performance (Gill et al., 1997). It is a fact that the ability to walk represents physical performance which significantly determines functional status, but its background is complex, synthesized from six subsystems; central nervous system, perceptual system, peripheral nervous system, muscles, bone/joints and energy production/delivery (Ferrucci et al., 2000). In this study, difficulty in walking affected more IADL performance than ADL. It is partly because IADL requires more sophisticated physical and cognitive performance. It should be noted that we should carefully interpret our results since our assessment was not quantitative but dichotomous, whether the subject was able to walk without any assistance or not. Some successful interventions such as exercise programs have been reported in terms of preventing physical frailty (Fiatarone et al., 1994; Cress et al., 1999) but little is known about whether they can prevent or delay the onset of functional decline in the long term. Considering walking is a part of basic daily activities and some indices evaluating functional status like the Barthel Index (Mahoney and Barthel, 1965) assess the ability to walk, walking difficulty may present an early warning sign of advancing dependency. Preventive care programs at communities will require simple and valid tools to assess lower-extremity strength at a point in time and how senior citizens lose independence in walking longitudinally.
Poor interest was another predictor of functional difficulty. Ishizaki et al. (2000) reported that intellectual inactivity assessed by the Tokyo Metropolitan Institute of Gerontology (TMIG) index, was an independent predictor of IADL deficit. Many studies suggested the association between cognitive impairment and loss of functional independence (Moritz et al., 1995; Gill et al., 1996; Greiner et al., 1996; Grigsby et al., 1998; Hebert et al., 1999). The association between intellectual inactivity and the risk of Alzheimer disease was also reported (Kondo et al., 1994; Wilson et al., 2002). Poor interest, in the initial stage of dementia, sometimes appears later than intellectual inactivity, but our results are consistent with other studies suggesting that intellectual activity and good cognitive functions are important for successful aging. As interventions such as cognitive training and intellectual stimulation were shown to improve cognitive abilities and prevent incidence of dementia (Ball et al., 2002; Wilson et al., 2002), adequate interventions into poor interest might prevent more people from getting functionally dependent. Such interventions, however, are difficult because interest connects with life style and character. Establishment of intellectually active lifestyle such as social participation at earlier life stage and preventive care programs such as day care service at older age are needed.

4.3. Total life expectancy and active life expectancy patterns

As shown in Fig. 1, men have advantage over women in functional independence. A similar trend was pointed out also in other studies (Leveille et al., 2000; Tsuji et al., 2002). Women are expected to spend longer period with functional dependence than men by around 1 year. At the age of 80 years or older, ALE in ADL among men is less than half a year, which is shorter than that of Ishizaki et al. (2002), 1.1–1.2 years. They used the same items to assess ADL performance as used here. The difference may be due to the difference in incidence rates of functional decline: 1.6 per 100 person-years in Minami Furano and 2.8 in Ishizaki’s study.

As for mortality, TLE among women is longer than among men at the age of 70 years or younger, and is similar between the sexes at older ages. While the proportion of period with independence in ADL to TLE among men remains over 90% in all ages, the equivalent among women falls from 90% of 65 years old to 79% of 85 years old. As shown in Table 4, women experience at least 2.3 years with IADL difficulty, whereas men have 2.7 years at most. Our results suggest that old men are expected to remain functionally well but develop disabilities more rapidly than women, who are expected to survive a long period with disability. Actually, about 90% of the institutionalized elderly are women in this town. As Sauvaget et al. (1999) suggested, the sex difference may be attributable to a difference in the etiology of the disability process in that women have higher prevalence in non-lethal and disabling diseases such as arthritis and osteoporosis and men are susceptible to lethal ones like cerebrovascular disease. Future surveys will clarify whether this explanation applies also to this town.

Because the number of elderly with disabilities will further increase with aging, not only preventive care programs to delay the onset of functional disability but also quality of life together with disability in later life stage, especially in women are to be taken into account. The strengths of our surveys are high coverage rates and annual assessment. So the estimated ALE reported here is reliable and will be used to evaluate health status of the
residents. In Japan, the LCI system is being developed and assessment of the outcomes has not been sufficiently done in terms of population. With the results of future surveys, transitions of functional status among senior citizens will be evaluated in the context of the LCI system. And ALE, similarly calculated in each municipality, will be used as an assessment tool for specific preventive care programs.

4.4. Study limitations

The first limitation of this study is validity of the questionnaire. The surveys were carried out by a local government to routinely assess the people, and many items were self-reported. The items drawn from a tool developed in terms of long-term care are slightly different from those used generally. Also valid information was not collected on some predictors such as subjective health status, depression and the number of chronic conditions, which may have some significance on the interpretation of the results. However, for both independent and dependent variables, core items were included and such a difference affects little the results presented here. And the questionnaire itself is being improved. For instance, since 2002, every subject has been asked how he or she perceives his or her own health to correctly assess subjective health status. Besides, the TMIG index of Competence, whose reliability and validity were demonstrated to be good (Koyano et al., 1991), was introduced in 2002 in addition to the items used before. The index covers also social role, one of important predictors (Stuck et al., 1999; Ishizaki et al., 2000). Higher level of social activities and social contact were reported to be associated with maintenance of a higher functional status (Stuck et al., 1999). In a cross-sectional analysis of 2002 survey, 35% (231/661) of those who were independent in ADL were categorized as having poor social role assessed by the TMIG index. Municipal programs encouraging social activity focused especially on such population may be effective. It is expected that this index will enable us to make more valid assessments of the population, more sensitive screening and more effective intervention programs for preventive care.

Second, our estimation of life expectancy does not consider recovery from disability due to unstable recovery rates observed from a small sample size and to inability to assess those institutionalized. ALE presented here may be therefore somewhat underestimated and can be interpreted as “duration free from disability and from institutionalization”.

Third, surveys at 1-year intervals can underestimate the real incidence of and recovery from disability (Gill et al., 2002). A number of senior citizens are reported to experience transient disability lasting only around 1-month, e.g. from falls (Gill et al., 2002; Gill and Kurland, 2003). One of the solutions to understand such dynamic transitions is to conduct more frequent assessments, but this is costly. Alternatively, a simple questionnaire asking temporal conditions is desired.

5. Conclusions

Preventive care programs should be conducted comprehensively considering physical, cognitive and social aspects. Gender specificity is also important to maximize of ALE and QOL during survival period with disability.
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