Table 3 clearly demonstrates that disability in Intellectual Activity or Social Role at baseline predicted significantly the onset of IADL disability in both areas and both genders that had no IADL disability at baseline, even after controlling for age and chronic medical conditions.

Discussion

Using the TMIG-Index of Competence, the present study investigated how community elderly people living in urban and rural areas lose higher-level functional capacity with advancing age, especially targeting on each sublevel; IADL, Intellectual Activity, and Social Role. Both the cross-sectional and longitudinal analyses demonstrated that Japanese elderly people living in rural area tend to lose Intellectual Activity first, followed by Social Role, while those living in urban area tend to lose Social Role, followed by Intellectual Activity. To our knowledge, this is the first article to report longitudinal changes in the higher-level functional capacity of community older residents, and to show that elderly people living in urban and rural areas differ in the loss of higher-level functional capacity.

As Lawton's model regards Social Role as the supreme competence[13] it is plausible to think that Social Role function is more likely impaired than Intellectual Activity in elderly people. However, higher-level functional capacities interrelate with each other, and are affected by socioeconomic status, educational attainment, cultural background, hobbies, or personal charm.[11,21] We also previously reported that chronic medical conditions,[17] self-rated health,[22] physical strength,[23] and baseline scores of each competence[21] contributed to changes in the TMIG Index of Competence in older community residents. All these potential factors may well distribute differently between urban and rural community older populations in Japan, which may lead to the differing way of losing higher-level functional capacity among older residents in two areas. Among the potential factors, we suppose at present that

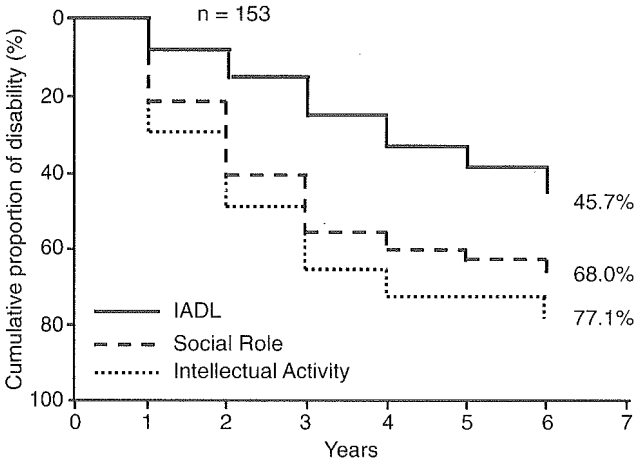

Figure 3 Declining patterns of the three subscales of TMIG-I of Competence for men in Nangai Village. IADL = Instrumental Self-Maintenance. Significant differences at $P < 0.01$ between each of three subscales by General Wilcoxon-Gehan test.

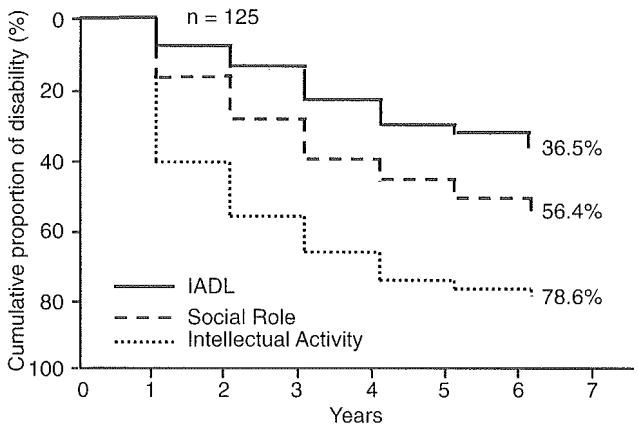

Figure 4 Declining patterns of the three subscales of TMIG-I of competence for women in Nangai Village. IADL = Instrumental Self-Maintenance. Significant differences at $P < 0.01$ between each of three subscales by General Wilcoxon-Gehan test.

Table 3 Not adjusted or adjusted hazard ratios for each disability at baseline in Intellectual Activity or Social Role against the onset of IADL disability during the 6-year follow-up period

Intellectual Activity Social Role	Urban area (Koganei) Hazard ratio	(95%CI)	*P*-value	Rural area (Nangai) Hazard ratio	(95%CI)	*P*-value
Model I[a]						
	1.68	(1.24–2.28)	0.001	1.63	(1.30–2.05)	< 0.001
	1.62	(1.24–2.10)	< 0.001	1.66	(1.29–2.13)	< 0.001
Model II[b]						
	1.41	(1.03–1.93)	0.032	1.45	(1.15–1.83)	0.002
	1.26	(0.96–1.66)	0.094	1.47	(1.14–1.89)	0.003

[a]Model I, Adjusted for only sex.
[b]Model II, Adjusted for age, sex, chronic conditions (stroke,hypertension,heart disease,diabetes).

a poor social network in urban community[24] and a relatively lower educational attainment in rural elderly people may explain at least in part the results; only 8.6% of Nangai subjects had 7 years or more education as compared with 86% of Koganei subjects. The precise mechanism, however, remains to be solved in future studies.

In the older populations of both urban and rural communities, disability in Social Role and Intellectual Activity preceded that in IADL among initially non-disabled elderly people. The multivariate analysis also showed the significant predictive value of baseline disability in Social Role and Intellectual Activity for the onset of IADL disability in both areas. These results strongly support a potential usefulness of two subscales for predicting future decline in IADL. In other words, an assessment with Intellectual Activity and Social Role scales may enable earliest detection of older persons who are at an increased risk of future IADL disability, and lead to earliest intervention. Further studies are needed to clarify an effective intervention program as well as risk factors for disability in two sublevels; Intellectual Activity and Social Role.

In summary, community-dwelling elderly people tend to lose Intellectual Activity and Social Role function prior to IADL impairment, indicating the usefulness of the TMIG Index of Competence subscales for predicting future decline in IADL.

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ORIGINAL ARTICLE

Impact of history or onset of chronic medical conditions on higher-level functional capacity among older community-dwelling Japanese adults

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Background: Many studies have examined the impact of chronic medical conditions on the age-related decline in basic activities of daily living (BADL) and the instrumental activities of daily living (IADL), but less is known concerning the influence of chronic disease on physical, cognitive, social, and economic aspects of higher-level functional capacity.

Methods: Subjects comprised 793 and 725 persons aged 65–84 years, living in an urban and a rural Japanese community, respectively. A baseline interview established any history of chronic medical conditions. Four years later, a second interview again assessed chronic disease, and higher-level functional capacity was evaluated using the Tokyo Metropolitan Institute of Gerontology (TMIG) Index of Competence.

Results: Multiple logistic regression analysis revealed that declines in total score and/or any of three subscales of the TMIG Index of Competence were significantly associated with a history of chronic disease, the onset of visual impairment and the development of hearing impairment, even after controlling for the subject's age, gender, educational attainment, and baseline TMIG Index of Competence. Episodes of stroke were significantly associated with declines in IADL. Hypertension, diabetes mellitus, and heart disease were also significantly associated with a decrease in functional competence, although each affected a different subscale of the TMIG Index of Competence.

Conclusions: The present results underline the importance of controlling chronic medical conditions through a physically active lifestyle and an appropriate medical regimen in order to limit the age-related decline in functional capacity.

Keywords: chronic medical conditions, older community residents, onset, past history, TMIG Index of Competence.

Introduction

'Successful aging'[1] is the ideal goal of an aging society. This multidimensional concept encompasses three distinct domains: the avoidance of disease and disability, maintenance of a high level of physical and cognitive

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function, and sustained engagement in social and productive activities. The needed functions mostly demand a higher-level of functional capacity than that evaluated by the Index of Instrumental Self-maintenance (IADL).[2] Chronic medical conditions make a major contribution to the age-related decline in physical, mental, and social health. Once a certain symptomatic or diagnostic threshold has been crossed, such conditions become essentially permanent, and they are very common among older adults.[3] Chronic medical conditions are also responsible for a major part of outpatient medical costs, accounting for almost a half of total medical care expenditures in Japan.[4]

Many studies have examined what conditions contribute to the decline in functional capacity.[5–16] However, most have focused on changes in the basic activities of daily living (BADL)[5–9,11–13] or instrumental activities of daily living (IADL)[10,14–16] rather than on losses of higher-level functional capacity.[17] In 1991, we launched a longitudinal interdisciplinary study on aging.[18,19] The TMIG Index of Competence[20] and the prevalence of chronic medical conditions were assessed on representative samples of elderly community residents from two different areas of Japan. In general, chronic medical conditions develop gradually. To prevent disuse syndromes and to evaluate the effects of rehabilitation[21] it is thus important to recognize both the short- and long-term impacts of chronic disease on higher-level functional capacity. The present study followed subjects for four years; it is the first to report the impact of chronic disease on our sample.

Materials and methods

Study locations and subjects

Data were drawn from the Tokyo Metropolitan Institute of Gerontology Longitudinal Interdisciplinary Study on Aging (TMIG-LISA).[18,19] The two locations studied were a suburb of Tokyo (Koganei City), and a rural village in northern Japan (Nangai, Akita Prefecture), In Koganei City, 439 men and 557 women were selected as a 10% random sample of subjects aged 60–84 years. Of the 996 originally contacted, 814 persons (81.7%) agreed to a baseline questionnaire-structured interview in their homes. There were a total of 940 community-dwelling residents aged 65–84 years in Nangai Village; 852 of these individuals completed baseline interviews at community halls in 1992. The present study is based on data for subjects who were living independently: 358 men and 435 women in Koganei City; 290 men and 435 women in Nangai Village. After an interval of four years, the baseline interview was repeated on 278 men and 315 women in Koganei City, and 241 men and 378 women in Nangai Village (Table 1).

Assessment of higher-level functional capacity

The TMIG instrument is a multidimensional, 13-item index of functional competence (Table 2). It provides an overall assessment of competence, and identifies three first-order subfactors (Instrumental Self-Maintenance, Intellectual Activity, and Social Role). Responses to individual items are scored as 1 ('yes', able to do) or 0 ('no', unable to do), The overall score is given by the simple sum of all 13 items, a higher score indicating greater functional competence. The three subscales have values of 0–5 for Instrumental Self-Maintenance, 0–4 for Intellectual Activity, and 0–4 for Social Role. Functional capacity was assessed both at baseline and at follow-up, using the TMIG index.

Assessment of chronic medical conditions

Subjects were asked whether they had a history of six major chronic conditions (hypertension, stroke, heart diseases, diabetes mellitus, hearing, and visual impairment), both at baseline and at follow-up. A 'yes' answer at baseline was defined as a history of the condition. On the other hand, we diagnosed a new onset of disease if they answered a 'no' answer at baseline, but a 'yes' at follow-up.

Statistical analyses

The SPSS/PC+ statistical software for Windows (version 11.0) was used for all statistical analyses. Data comparisons of baseline characteristics between Koganei and Nangai were tested with χ^2 test for categorical variables and the Mann–Whitney *U*-test for age and family members. Relationships between a past history or the onset of any of the six chronic conditions and changes in the TMIG Index of Competence were explored using a χ^2 test (Fisher's exact probability test). Our previous reports had demonstrated effects of age, gender, educational attainment, and baseline TMIG-Index on subsequent changes in TMIG Index.[9,10] Accordingly, a multiple logistic regression analysis explored the effects of chronic medical conditions while controlling for the above variables. The goodness of fit of each model was assessed using the Hosmer-Lemeshow test.

Results

Some 30% of subjects in Koganei (33.8% of men *vs* 31.1% of women) and 40% of those in Nangai (39.8% of men *vs* 41.0% of women) showed a decline in total TMIG Index of Competence scores over the four-year period, the proportions showing a statistically similar decline in women and in men.

Tables 3 and 4 examine the proportions of subjects showing a decline of TMIG Index in relation to their

Table 1 Characteristics of participants in the present study

	Koganei City	Nangai Village	Test
Baseline survey			
n	793	725	
Female (%)	54.2	60.0	*
Age (years, Mean ± SD)	71.9 ± 5.2	71.5 ± 5.0	
Family members (n, Mean ± SD)	3.2 ± 1.7	4.6 ± 1.9	**
Education years (% < 7 years)	8.6	86.0	**
Subjective Health (% excellent or good)	78.6	70.2	**
Use of outpatient care in the past month (% yes)	63.4	77.0	**
Admission to hospital in the past year (% yes)	7.9	12.3	**
Past history of:			
hypertension (% present)	36.1	42.1	**
stroke (% present)	3.9	5.2	
heart disease (% present)	20.1	22.1	
diabetes (% present)	9.4	7.4	
hearing impairment (% present)	8.2	14.8	**
visual impairment (% present)	6.4	7.3	
TMIG-Index of Competence score (% full mark)			
Total scores	58.5	38.5	**
Instrumental Self-Maintenance	88.3	82.1	**
Intellectual Activity	78.6	48.3	**
Social Role	66.3	70.5	
Follow-up survey	**n (%, female)**	**n (%, female)**	
Respondents	593 (53.1)	619 (61.1)	
Non-respondents:			
In hospitals or institutions	21 (61.9)	24 (58.3)	
Long-term absence	22 (59.1)	3 (100.0)	
Deceased	62 (43.5)	73 (50.7)	
Refusal or other reason	95 (70.5)	6 (50.0)	

Respondents to the follow-up survey were the subjects of the analysis.
TMIG, Tokyo Metropolitan Institute of Gerontology.
*$P < 0.05$, **$p < 0.01$.

Table 2 The TMIG Index of Competence for assessing higher-level functional capacity in older adults

Sub-scales	Questionnaires	
Instrumental Self-Maintenance		
1 Can you use public transportation (bus or train) by yourself?	1. Yes	0. No
2 Are you able to shop for daily necessities?	1. Yes	0. No
3 Are you able to prepare meals by yourself?	1. Yes	0. No
4 Are you able to pay bills?	1. Yes	0. No
5 Can you handle your own banking?	1. Yes	0. No
Intellectual Activity		
6 Are you able to fill out forms for your pension?	1. Yes	0. No
7 Do you read newspapers?	1. Yes	0. No
8 Do you read books or magazines?	1. Yes	0. No
9 Are you interested in news stories or programs dealing with health?	1. Yes	0. No
Social Role		
10 Do you visit the homes of friends?	1. Yes	0. No
11 Are you sometimes called on for advice?	1. Yes	0. No
12 Are you able to visit sick friends?	1. Yes	0. No
13 Do you sometimes initiate conversations with young people?	1. Yes	0. No

Table 3 Proportion of subjects from Koganei City and Nangai Village who showed a decline in the TMIG-Index of Competence over 4-year follow-up, clasified by *past history* of chronic medical conditions

	Total	Subscales Instrumental Self-maintenance	Intellectual Activity	Social Role
Koganei City				
Hypertension				
No (n = 381)	30.4	11.7	17.5	23.7
Yes (n = 215)	35.3	19.7**	19.0	30.6
Stroke				
No (n = 573)	31.9	14.7	17.6	25.9
Yes (n = 20)	45.0	19.0	28.6	45.0
Heart diseases				
No (n = 480)	30.6	13.2	18.1	24.6
Yes (n = 112)	38.4	21.4	16.8	33.0
Diabetes				
No (n = 542)	30.6	13.5	17.8	30.9
Yes (n = 55)	49.1**	27.3**	20.0	25.9
Hearing impairment				
No (n = 548)	31.8	14.5	17.8	25.8
Yes (n = 45)	42.2	19.6	21.7	35.6
Visual impairment				
No (n = 562)	30.6	13.4	16.8	25.0
Yes (n = 31)	67.7**	41.9**	41.9**	54.8**
Nangai Village				
Hypertension (n = 357)	40.1	18.7	27.8	24.0
Yes (n = 262)	41.2	24.8	30.3	26.2
Stroke				
No (n = 591)	40.6	10.7	29.2	24.6
Yes (n = 28)	39.3	21.8	28.6	32.1
Heart disease				
No (n = 495)	40.2	19.2	29.2	23.7
Yes (n = 124)	41.9	29.8*	29.0	29.8
Diabetes				
No (n = 582)	40.0	20.9	29.0	24.3
Yes (n = 37)	48.6	27.0	32.4	35.1
Hearing impairment				
No (n = 540)	40.2	20.0	28.5	23.1
Yes (n = 79)	43.0	30.4*	33.8	37.5**
Visual impairment				
No (n = 579)	39.9	20.2	29.4	24.1
Yes (n = 39)	51.3	38.5*	27.5	37.5

TMIG, Tokyo Metropolitan Institute of Gerontology.
*P < 0.05, **P < 0.01.

past history, and to the onset of chronic disease, respectively. The most consistent finding at both locations was an association between visual and hearing impairments and a decrease in total score and/or scores for any of three subscales of the TMIG Index (the one exception was a past history of hearing impairment in Koganei). The onset of stroke was significantly associated with declines in total and/or subscale TMIG Index scores in both locations. Hypertension, diabetes mellitus, and heart disease were each significantly associated with a decrease in functional competence, although different subscales were affected in the two locations.

Tables 5 and 6 show odds ratios for a decline in the TMIG Index of Competence relative to a history of

Table 4 Proportion of subjects from Koganei City and Nangai Village who showed a decline in the TMIG-Index of Competence over 4-year follow-up, clasified by *onset* of chronic medical conditions

	Total	Subscales Instrumental Self-maintenance	Intellectual Activity	Social Role
Koganei City				
Hypertension				
No (n = 350)	27.7	12.7	22.2	22.0
Yes (n = 63)	44.4*	18.8	16.7	34.4*
Stroke				
No (n = 512)	30.7	13.5	16.8	24.9
Yes (n = 11)	72.7**	72.7**	36.4	45.5
Heart diseases				
No (n = 399)	29.6	12.1	17.3	23.5
Yes (n = 44)	40.9	29.5**	17.8	35.6
Diabetes				
No (n = 573)	31.8	14.3	18.2	26.2
Yes (n = 8)	37.5	12.5	12.5	12.5
Hearing impairment				
No (n = 491)	30.5	13.1	16.3	25.1
Yes (n = 59)	44.1*	28.8**	33.3**	33.9
Visual impairment				
No (n = 521)	28.8	12.0	15.2	24.1
Yes (n = 42)	54.8**	35.7**	39.5**	34.9
Nangai Villige				
Hypertension				
No (n = 531)	39.2	19.9	27.8	23.3
Yes (n = 66)	43.9	21.2	30.3	28.8
Stroke				
No (n = 538)	37.4	17.6	26.2	22.0
Yes (n = 25)	80.0*	60.0**	64.0**	48.0**
Heart diseases				
No (n = 399)	38.1	15.8	26.8	21.4
Yes (n = 66)	39.4	19.7	31.8	24.2
Diabetes				
No (n = 561)	38.3	18.3	27.2	23.1
Yes (n = 23)	43.5	26.1	26.1	21.7
Hearing impairment				
No (n = 479)	37.8	18.3	27.6	21.5
Yes (n = 61)	59.0**	32.8**	36.1	36.1*
Visual impairment				
No (n = 539)	38.0	18.3	27.6	23.7
Yes (n = 40)	65.0**	45.0**	52.5**	30.0

TMIG, Tokyo Metropolitan Institute of Gerontology.
*$P < 0.05$, **$P < 0.01$.

chronic disease and the onset of various conditions, respectively. The Hosmer-Lemeshow test demonstrated a good fit in all models (data not shown). Even after controlling for a subject's age, gender, educational attainment, and baseline TMIG-Index, a past history of visual impairment or its onset during the 4 years follow-up remained significant predictors of declines in total and subscale TMIG Index scores (odds ratio = 3.06–4.07, $P < 0.01$) in Koganei (Table 5), and in total, IADL and Intellectual Activity (odds ratio = 2.32–3.85, respectively, $P < 0.05$ in both locations) (Table 6).

Table 5 Odds ratios† relating *past history* of chronic medical conditions to decline in the TMIG-Index of Competence over 4-year follow-up in Koganei City and Nangai Village

	Total	Instrumental Self-maintenance	Intellectual Activity	Social Role
Koganei City				
Hypertension	1.13 (0.77–1.65)	1.85 (1.13–3.04)*	0.96 (0.81–1.52)	1.34 (0.90–1.99)
Stroke	1.10 (0.38–3.19)	0.51 (0.11–2.41)	0.91 (0.24–3.38)	1.85 (0.61–5.62)
Heart diseases	1.26 (0.80–1.99)	1.52 (0.86–2.69)	0.76 (0.43–1.37)	1.37 (0.85–2.21)
Diabetes	2.25 (1.25–4.07)**	2.41 (1.21–4.79)*	1.22 (0.59–2.52)	1.33 (0.70–2.51)
Hearing impairment	1.01 (0.51–2.01)	0.65 (0.26–1.63)	0.74 (0.32–1.71)	1.11 (0.54–2.27)
Visual impairment	4.07 (1.79–9.24)**	3.82 (1.70–8.59)**	3.48 (1.53–7.95)**	3.06 (1.39–6.73)**
Nanagi Village				
Hypertension	1.01 (0.71–1.42)	1.28 (0.83–1.97)	0.94 (0.85–1.37)	1.07 (0.72–1.61)
Stroke	1.45 (0.61–3.46)	0.51 (0.11–2.42)	1.23 (0.49–3.12)	2.80 (1.12–7.03)*
Heart disease	1.16 (0.75–1.79)	2.08 (1.26–3.44)**	1.00 (0.63–1.59)	1.42 (0.87–2.31)
Diabetes	1.30 (0.63–2.70)	1.47 (0.62–3.50)	1.11 (0.52–2.40)	2.53 (1.18–5.45)*
Hearing impairment	0.91 (0.52–1.60)	1.66 (0.88–3.13)	1.09 (0.61–1.95)	1.45 (0.78–2.67)
Visual impairment	1.55 (0.75–3.17)	1.63 (0.76–3.48)	1.44 (0.64–3.21)	1.32 (0.63–2.78)

†Data adjusted for age, sex, educational attainment and baseline level of the TMIG-Index of Competence. TMIG, Tokyo Metropolitan Institute of Gerontology.
95% confidence intervals of odds ratios are shown in parentheses. *p < 0.05, **p < 0.01.

Table 6 Odds ratios† relating *onset* of chronic medical conditions to decline in the TMIG-Index of Competence over 4-year follow-up in Koganei City and Nangai Village

	Total	Instrumental Self-maintenance	Intellectual Activity	Social Role
Koganei City				
Hypertension	2.40 (1.31–4.41)**	1.96 (0.85–4.52)	1.44 (0.70–2.97)	2.08 (1.10–3.96)*
Stroke	4.30 (0.98–18.95)	10.80 (2.48–47.00)**	1.49 (0.33–6.68)	1.62 (0.39–6.63)
Heart diseases	1.48 (0.73–3.00)	2.93 (1.29–6.66)*	0.89 (0.37–2.16)	1.66 (0.81–3.40)
Diabetes	1.17 (0.26–5.24)	0.76 (0.09–6.68)	0.67 (0.08–5.68)	0.35 (0.04–2.95)
Hearing impairment	1.19 (0.64–2.20)	1.62 (0.78–3.35)	1.77 (0.91–3.46)	1.10 (0.58–2.10)
Visual impairment	2.32 (1.16–4.64)*	2.72 (1.26–5.90)*	3.10 (1.49–6.44)**	1.27 (0.61–2.65)
Nangai Village				
Hypertension	1.30 (0.73–2.30)	1.48 (0.70–3.13)	1.16 (0.63–2.14)	1.44 (0.75–2.76)
Stroke	6.65 (2.39–18.54)**	10.32 (4.00–26.64)**	4.52 (1.91–10.73)**	3.63 (1.50–8.78)**
Heart disease	1.02 (0.59–1.76)	1.12 (0.55–2.29)	1.33 (0.74–2.39)	1.06 (0.55–2.03)
Diabetes	1.26 (0.53–3.01)	1.80 (0.65–5.00)	0.93 (0.35–2.50)	0.93 (0.32–2.67)
Hearing impairment	1.80 (1.01–3.22)*	1.49 (0.77–2.88)	1.29 (0.71–2.34)	1.30 (0.69–2.45)
Visual impairment	3.00 (1.47–6.09)**	2.99 (1.45–6.16)**	3.85 (1.88–7.86)**	1.05 (0.49–2.25)

†Data adjusted for age, sex, educational attainment and baseline level of the TMIG-Index of Competence. TMIG, Tokyo Metropolitan Institute of Gerontology.
95% confidence intervals of odds ratios are shown in parentheses. *p < 0.05, **p < 0.01.

An episode of stroke was a strong predictor of declines in both total and subscale TMIG Index scores (odds ratio = 3.63–10.32, $P < 0.01$) in Nangai, and in IADL (odds ratio = 10.80, $P < 0.01$ in Koganei) (Table 5). Hypertension, diabetes mellitus, and heart disease were also significant but moderate predictors of functional decline, although different subscales were affected in the two locations (odds ratio = 1.85–2.93, $P < 0.05$) (Tables 5 and 6).

Discussion

This prospective study has demonstrated for the first time that how chronic medical conditions influence the

rate of deterioration of higher-level seems to vary, depending on disease categories and study locations.

The mortality rate from stroke has been decreasing in Japan, due to both a decreased incidence of the condition and an improvement of prognosis among those who are affected.[22] The mortality from stroke remains higher in northern Japan than in the southern region[23] and in keeping with this finding, our cohort in Nangai showed a higher incidence of stroke (5.2%) than the cohort from Koganei (3.9%, Table 1). As in previous reports[7,24] stroke remains a significant and strong predictor of functional decline, especially with respect to IADL.

Visual impairment was a strong and significant predictor of poor scores on both the total and subscales of the TMIG Index of Competence, the exception being a past history of visual problems in Nangai. In agreement with our data, previous reports noted that visual impairment was associated with an increased risk of falls and hip fractures,[25] depression,[26] and overall mortality.[27,28] Those with visual impairments also needed help with their grocery shopping[29] and both BADL and IADL showed diminished functional status.[30] The onset of stroke (both locations) and visual impairment (Nangai only) had a greater negative impact on functional capacity than a past history of chronic disease. In general, both types of impairment developed quickly, thus making patients conscious of inconvenience and anxious about the loss of function. In contrast, hypertension and diabetes mellitus progress slowly and silently, and are often not identified until serious complications have occurred.

Hearing impairment is associated with a decline in functional capacity[30–32] (Tables 3 and 4). The proportion of individuals with a history of hearing impairments was higher in Nangai (14.8%) than in Koganei (8.2%) (Table 1). However, after adjusting for age and the other compound factors, onset of hearing impairment significantly remained only in total score of TMIG-Index of Competence in Nangai (Table 6). We think it likely that hearing impairment developed gradually as subjects grew older and was therefore less obvious than any visual loss. Older people can check their vision regularly by reading characters in newspapers or advertisements, and thus recognize their visual impairment at an early stage. Most instances of visual impairment reflected the development of cataracts, and vision was frequently dramatically improved by a basic operation. Visual impairment causes great inconvenience in urban life; it predisposes to traffic accidents, and leads to unsatisfactory interpersonal communication with clerks, civil servants, railway station staff, and so on. In contrast, the rural subjects get much daily support from their family (respective number of family members, mean ± SD, 3.2 ± 1.7 *vs* 4.6 ± 1.9, Table 1) and helpful neighbors. Thus, the functional capacity of subjects in Nangai is less dependent on visual function, and individuals can ignore visual impairments, often making little use of spectacles in daily life.

Past history of diabetes remained as a significant risk factor of decline in IADL and total score of TMIG-Index of Competence in only Koganei after adjusting for age and the other compound factors. Volpato *et al.*[33] reported that visual impairment and cardiovascular diseases (CVD) were substantial mediators of association between diabetes and ADL disability. There were no differences in prevalence of comorbidities with diabetes between Koganei and Nangai among subjects who showed decline in IADL (visual impairment, 2 persons [50%] *vs* 2 persons [50%]; stroke, 0% *vs* 0%; heart diseases, 8 persons [38%] *vs* 3 persons [33%], Koganei and Nangai respectively) and total score of TMIG-Index of Competence (visual impairment, 3 persons [75%] *vs* 4 persons [100%]; stroke, 0% *vs* 1 person [50%]; heart diseases, 6 persons [66%] *vs* 11 persons [52%], Koganei and Nangai respectively), though impacts of these comorbidities with diabetes on functional decline were unclear due to small numbers of their prevalence. One possible explanation for this regional difference was due to psychosocial factors. Depression among diabetic older people was associated with disability[33] and whether the burden of diabetes will lead to depression may also depend on the level and quality of social support.[34] Koganei and Nangai may have several different sociocultural characteristics, such as mean family members. Thus, these different characteristics may some effect on association diabetes and functional decline.

We did not always obtain the findings that we expected in our study. This might reflect limitations in the validity of self-reported diagnoses. Bergmann *et al.*[35] noted that the accuracy of self-reports for ischemic heart diseases and cataracts was high (> 80%), but dropped to about 70% for other major chronic medical conditions. As when predicting death, objective or quantitative evaluations (biochemical data, electrocardiograms, ultrasonography and the like), are more reliable than self-reports for most medical conditions except congestive heart failure.[36] Bush *et al.*[37] also found substantial or moderate agreement between self-reports and their medical records, although the strength of agreement varied by condition. Our present approach excluded individuals with uncertain or undiagnosed diseases, and possibly underestimated the total prevalence of disease. The apparently small number of patients with stroke, diabetes mellitus, and visual impairment at both locations supports this contention. Furthermore, it was uncertain whether subjects who had no history of the six chronic conditions at the baseline survey and were in hospitals or institutions at the follow-up survey had onset of these chronic conditions during 4 years. These possible subjects (21 persons in Koganei and 24 persons in Nangai) were excluded in the

analysis. Thus, we might underestimate onset of these chronic conditions. Future studies should develop a more sophisticated method of counting chronic medical conditions and obtaining information of non-respondents, in part by determining whether the subjects are receiving regular treatment in cooperation with their proxies, hospitals, and institutions.

Although account should be taken of these limitations of methodology, we remain confident in using the prevalence of self-reported medical conditions as our index of health. Japanese outpatients with the six chronic conditions of interest can easily learn the name of their diseases through the explanations provided by an attending physician. Most of them must visit a doctor at least once every 2–4 weeks to obtain prescribed medication, so they naturally and repeatedly recognize why they are seeing their physician. Further, the doctor typically explains these six conditions to the patient. In contrast, a diagnosis of cancer or dementia is not necessarily revealed.[38] We thus excluded these diseases from our analysis. Finally, the symptoms from the six diseases were characteristic and clear to most patients; for example, there was usually palsy in stroke, chest discomfort in heart disease, recommendations of diet and exercise for diabetes, and limitation of sodium intake with self-monitoring of blood pressure for hypertension.

In addition to the provision of appropriate medical care, the adoption of a physically active lifestyle plays an important part in delaying the functional consequences of chronic disease, and increasing active life expectancy. Mor *et al.*[27] demonstrated that after controlling for reported medical conditions and demographic factors, those who did not report regular exercising or walking (1.6 km 4–7 days per week) were 1.5 times more likely to show a decline in function. Likewise, Shinkai *et al.*[39] reported that walking speed (especially maximum walking speed) was the most sensitive predictor of a decline in functional capacity, even after controlling the analysis for the number of chronic medical conditions reported by the individual. There remains a need for further study of the effects of preventive health practices and the adoption of a healthy active lifestyle upon the functional competence of older community dwelling adults.

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ORIGINAL ARTICLE

Active life expectancy based on activities of daily living for older people living in a rural community in Japan

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Objectives: To examine functional transitions in activities of daily living (ADL) over a one-year interval among older Japanese living in a rural community, and to estimate their active life expectancy (ALE) based on ADL.

Design: A prospective cohort study.

Setting: A community-based environment.

Participants: A total of 1069 residents aged 65 or older in Nangai Village, Akita, Japan

Measurements: A structured interviewed questionnaire, which involved age, sex, and four ADL items, was used for each survey in both 1996 and 1997. We defined functional dependency in ADL as a loss of independence in any ADL item. In addition, we defined ALE as the average number of remaining life years free of ADL dependence at a given age.

Results: Of the baseline cohort (n = 1069), we received 1068 analyzable questionnaires at the follow-up survey in 1997. During the follow-up, 95% of subjects who were initially independent in ADL remained independent. Active life expectancies for men and women were estimated to be 15.4 and 17.8 more years at 65 years of age, respectively.

Conclusion: The study revealed that women had longer average life years than men in terms of ADL disabilities.

Keywords: active life expectancy, activities of daily living, functional transition, older people.

Introduction

Since the World Health Organization proposed the use of autonomy or independence in functioning as a health index for older people, in addition to mortality and morbidity,[1] many reports identifying physical functioning for older people living in communities have been published. As a new health index for older population, Katz *et al.* reported active life expectancy (ALE), which represents the degree of independence to perform activities of daily living (ADL) among older people.[2] ALE is a useful health index for an aging population because it combines information on functional status and mortality into a single and meaningful summary measure. Nevertheless, only a limited number of studies on ALE estimation for elderly Japanese populations have been

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reported during the last decade.[3–8] To identify additional information on ALE estimation for a Japanese population in a community, we identified functional transitions in ADL and estimated ALE based on ADL among older people in a rural community in Japan.

Methods

The sources of data for this study were from the Longitudinal Interdisciplinary Study on Aging, which is being conducted by the Tokyo Metropolitan Institute of Gerontology (TMIG), and aims to identify risk factors for geriatric diseases or chronic medical conditions, and to search for factors accelerating or decelerating the aging process in representative samples. Sampling methods of subjects have been described in detail elsewhere.[9,10] Briefly, the study area, Nangai Village, a rural area of Akita Prefecture in the northern area of the Honshu, one of the four main islands in Japan, is mainly agricultural. The total population of the village was 4983 in 1995. All residents aged 65 or older who lived in the village (n = 1069) were asked to participate in the baseline survey held from July to August 1996. These people have been followed-up by interview survey on a yearly basis. Each survey was carried out in municipal community centers in Nangai Village. When a subject was unable to walk, the survey was done by home visit.

A structured interviewed questionnaire involved age, sex, and ADL items. The ADL was measured using four items: walking, feeding, bathing, and dressing. When a subject replied to be able to do without help of another person, he/she was regarded as independent. On the other hand, when a subject replied to be unable to do without help of another person, he/she was regarded as dependent. We defined 'dependent in ADL' as a loss of independence in each item of ADL. Because the present study sought to estimate ALE during a one-year follow-up, we used functional status data obtained from the follow-up surveys conducted in 1997 as outcome measures. Then, we defined ALE as the average number of years for which an individual of a given age was expected to live free of functional dependence in ADL. We also defined inactive life expectancy (ILE) as the average number of years for which an individual of a given age was expected to live with dependence in ADL.

First, we noted the proportion of subjects who were independent in ADL. Second, we described functional transitions in ADL. For each functional status, there were two initial status states, independent and dependent, and there were three states during the one-year follow-up: independent, dependent, and dead. Third, for those independent or dependent at the beginning of the one-year interval, age- and sex-specific transition probabilities for the six transitions in ADL (from independent to independent, dependent, or dead; from dependent to independent, dependent, or dead) were calculated using a multinomial logit regression model.[11] In the regression model, the dependent variable was functional status in ADL during the one-year follow-up and independent variables were age and sex. Goodness of fit tests of the logit model were performed using log-likelihood ratio test statistics. The age- and sex-specific transition probabilities were calculated for each year of age up to 89-year-old using parameter estimates for each model, and subjects aged 90 or older were combined for this estimation because of their low numbers. Finally, using the transition probabilities, we created single-year increment-decrement life tables for total life expectancy (TLE), ALE, and ILE, using the methodology described by Branch et al.[12] Data analysis was performed with the SPSS/PC statistical package Version 10.0.[13]

Results

In the survey in 1996, 1069 people aged 65 or older lived in Nangai Village. All of them participated in the survey in 1996. The next survey was conducted in July 1997. Among the effective cohort of 1069 in 1996, 1030 participated in the survey in 1997; 38 had died, and one did not respond to any item in the interview survey. Finally, estimation of ALE in this study was based on a total of 1068 subjects. The average age of the subjects was 72.8 (± 6.4) years old, (men = 40.9%) in 1996.

Table 1 shows that about 90% of the subjects were initially independent in performing all items of ADL in 1996. Table 1 also shows that proportions of subjects who were independent in ADL in 1996 decreased with advancing age in both sexes. Women aged 65–79 presented almost similar proportions for being independent in ADL to men of the same age, whereas men aged 80 or older were more likely to be dependent in ADL than women of the same age. Table 2 shows functional transitions in ADL between 1996 and 1997. During the one-year interval, over 95% of the subjects who were initially independent in ADL remained independent. On the other hand, among subjects who were initially dependent in ADL, 15% of men and 13% of women had improved and become independent at the time of the second survey.

Using the increment-decrement life tables method, Table 3 shows the TLE, ALE, and ILE for selected ages. For comparison purposes, the TLE for both the population in Japan and in Akita Prefecture in 1995[14] is also shown in Table 3. The ALE for women aged 65 (17.8 years) was 2.4 years longer than that for men aged 65 (15.4 years) and the difference in ALE between men and women became smaller with advancing age. In addition, the ILE did not change very much with increasing age for men or women. Table 3 also shows

Table 1 Percentages of people who were independent in each item of activities of daily living in Nangai Village in 1996

Age	Transferring		Eating		Bathing		Dressing		Total	
	Men $n = 437$	Women $n = 631$	Men $n = 437$	Women $n = 631$	Men $n = 437$	Women $n = 631$	Men $n = 437$	Women $n = 631$	Men $n = 437$	Women $n = 631$
65–69	97.2	99.1	97.8	99.1	97.2	98.7	97.8	99.6	95.6	98.2
70–74	93.2	94.7	93.9	96.5	94.7	95.3	95.5	96.5	92.4	94.2
75–79	94.3	93.2	94.3	96.6	90.0	92.4	91.4	95.8	90.0	91.5
80–84	72.7	83.3	90.9	90.3	75.8	84.7	87.9	87.5	69.7	83.3
85+	68.2	65.2	68.2	84.8	54.5	71.7	59.1	80.4	50.0	60.9
Total	92.2	92.6	94.1	95.9	91.5	93.0	93.4	95.2	89.5	91.4

Table 2 Functional transitions in activities of daily living (ADL) by age during a one-year follow-up between 1996 and 1997 in Nangai Village, Japan ($N = 1068$)

Age class	Subjects who were independent in ADL in 1996				Subjects who were dependent in ADL in 1996			
	n	Status in 1997 (%) independent	dependent	dead	n	Status in 1997 (%) independent	dependent	dead
Men								
65–69	172	98.3	0.6	1.2	8	12.5	87.5	0.0
70–74	122	96.7	0.0	3.3	10	30.0	50.0	20.0
75–79	63	88.9	11.1	0.0	7	0.0	100.0	0.0
80–84	23	95.7	4.3	0.0	10	10.0	40.0	50.0
85+	11	63.6	9.1	27.3	11	18.2	45.5	36.4
Total	391	95.1	2.6	2.3	46	15.2	60.9	23.9
Women								
65–69	220	99.1	0.5	0.5	4	25.0	75.0	0.0
70–74	161	97.5	1.9	0.6	10	10.0	90.0	0.0
75–79	108	93.5	3.7	2.8	10	10.0	70.0	20.0
80–84	60	93.3	6.7	0.0	12	8.3	66.7	25.0
85+	28	71.4	21.4	7.1	18	16.7	50.0	33.3
Total	577	95.7	3.1	1.2	54	13.0	66.7	20.4

the proportion of remaining life years with independence in ADL at a selected age. The proportion of remaining life years with independence in ADL at 65 was about 90% for men and women. Men demonstrated very similar patterns in the percent of ALE to TLE to women.

Discussion

To examine functional health for older Japanese living in a community, we described functional transitions in ADL and estimated their ALE based on a one-year observation in Nangai Village. During the one-year follow-up, 95% of subjects who were initially independent in ADL remained independent. The ALEs for men and women were estimated to be 15.4 and 17.8 at 65 years old, respectively. The proportion of remaining life years with independence in ADL at 65 was about 90% for men and women. The proportion at any age did not greatly differ between men and women.

Although our follow-up surveys were conducted using a small number of residents living in a rural area, we still believe that our study on ALE is relevant to recent efforts to estimate accurate ALE for older people. First, almost all subjects living in the community were followed-up in this study, so we assume that almost no loss to follow-up made it possible to estimate both ALE and TLE more precisely among the elderly people living in the community. Our estimation of the TLE at age 65 (16.8 for men and 19.6 for women) was almost the same as the TLE at 65-years-old in Nangai Village, reported in the municipal life tables (16.2 for men and 20.7 for women in 1995).[14] In addition, we believe that it was appropriate for us to estimate age- and sex-specific transition probabilities for the three transitions in ADL using a multinomial logistic regression model.

Table 3 Total life expectancy and active life expectancy of selected age among older people in Nangai Village, Japan, 1996

Age	Total life expectancy after 65 years			Active life expectancy for 1068 samples in Nangai Village		
	Population in Japan, 1995† (year)	Population in Nangai Village, Japan, 1995† (year)	1068 samples in Nangai Village (year)	Active life expectancy (year)	Inactive life expectancy (year)	Proportion of remaining of life which was independent in activities of daily living (%)
Men						
65	16.7	16.2	16.8	15.4	1.4	91.7
70	13.2	12.7	12.7	11.3	1.4	88.8
75	NA	NA	9.1	7.7	1.4	84.7
80	NA	NA	6.1	4.8	1.3	78.6
85	NA	NA	3.7	2.5	1.2	68.7
Women						
65	21.2	20.7	19.6	17.8	1.8	91.1
70	17.0	16.5	15.0	13.3	1.7	88.4
75	NA	NA	10.9	9.2	1.7	84.8
80	NA	NA	7.2	5.7	1.5	78.8
85	NA	NA	4.2	2.9	1.3	69.5

†Source: Ministry of Health and Welfare. 1995 Municipal life tables. Kosei Tokei Kyokai, Tokyo, 1998. NA = data not available.

There are some differences when we compare the results of this study with other studies that estimated ALE among older Japanese living in communities. The first issue is variations in definition of functional independence in ADL. Tsuji *et al.* pointed out that it would be safe to note that the differences in other ADL tasks, as ADL criteria for disability have only a minor influence on ALE estimation.[4] However, we guess that the number of items in ADL may have some influence on ALE estimation if disability in an additional ADL item is more prevalent than that in other items. Therefore, we selected the same ADL items as the other studies[4,6,7] to define functional independence in ADL, although we used five ADL items, including walking, feeding, bathing, dressing, and incontinence in this study. As for the second issue, we must consider the representativeness of the analyzable sample among the whole community in which the study was conducted. If the response rate of the study is relatively low, we must consider the effect of sampling bias on the ALE estimation.[15] We propose that it is useful to compare the estimated TLE in the study with the TLE in the same community derived from the national census appearing in municipal life tables.[14] If the estimated TLE is similar to the TLE in the municipal life tables, the sample may be considered to be representative of the targeted population in the community. The next issue is the degree of accuracy in identifying functional transitions. In the TMIG-LISA project, ADL has been measured using an ADL scale similar to the modified Katz's ADL scale.[2] We consider that the scale is sufficiently valid, because the distributions of ADL among the entire sample in this study were similar to those for studies conducted in other areas of Japan.[8,16] Therefore, we believe that this study identified functional transitions in ADL in a reliable and valid manner. Taking into account the above issues, we consider that the estimation of ALE in this study has some degree of validity.

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