致しない．これは，研究の方法や対象の違いが考えられるが，この点については今後明らかにしていく必要がある．

先行研究によると持久的な運動の継続により，心拍数が低下することが報告されている[13~18]．これは持久的な運動が自律神経活動に影響し，副交感神経優位になることに起因する．これら先行研究の多くは，運動強度や頻度，期間を厳密に調整し，一定強度以上の運動条件で実施される laboratory-based による報告が多い．また，自己管理型の運動の影響について報告されている中高年者を対象とした在宅型のトレーニングの実施による検討では，中強度の運動でも心肺機能は改善し，安静時の心拍数は低下することが報告されている[26]．このように，心拍数の低下には持久的な運動のみではなく，自己管理型の運動でも心肺機能に影響を及ぼすことが示されている．

本研究は長期縦断研究であり，研究のデザインは先行研究と異なる．また，運動の種類や強度，頻度なども一定ではない．しかし，ベースラインの1992年から1996年までの運動習慣の継続状況別に1996年，および2000年の心拍数の差を比較すると，女性においてのみ，運動なし群では心拍数の増加がみられたが，運動中断群，運動継続群では増加は認められず，運動が心拍数の経時的な変化に影響していることが示された．さらに，年齢や心拍数に影響する因子を調整した上で分析を行っても，運動習慣の継続は4年間後の心拍数に影響を及ぼしており，運動の効果は比較的長期にわたり継続することが示された．これは高齢期における運動効果の重要性を示す知見であり，さらに精査する必要がある．

また，心拍数に対する運動の影響は女性のみで確認された．これは，男性に比べ女性の体力レベルが相対的に低く，より効果的に運動の継続状況が心拍数の増加の抑制に作用したことが考えられる．本研究では，運動の継続状況別に体力指標についても比較を行った．その結果，女性における歩行速度は，運動なし群，運動中断群に比べて運動継続群で高い値を示したが，男性ではこの差は認められなかった．つまり，本研究で用いた運動習慣は女性での加齢に伴う体力低下を抑制できる運動強度であり，よって，女性で見られたような運動効果を男性で得るためには，さらに強度や頻度の高い運動の実施が必要であることが考えられる．この点については今後検討すべき点である．

他方，男性では，ベースラインの喫煙状況が心拍数の変化に影響しており，喫煙がある場合に心拍数の増加を抑制していた．一般的に喫煙により心拍数は影響を受け，安静時心拍数は非喫煙者より喫煙者で高い[22,27,28]という本研究の結果とは対極の報告が多い．喫煙に伴う心拍数の増加については，エピネフリンの増加や β-adrenoceptor の低下[29]，交感神経活動の増加や副交感神経活動の低下など，喫煙により心拍調節機能が鈍化することに起因すると報告されている．また，喫煙による死亡リスクの増加はこの心周期のアンバランスにより引き起こされるなど[30]，喫煙が心機能に悪影響を及ぼすことが報告されている．喫煙が心拍調節機能に何らかの影響を及ぼしていることが考えられるが，本研究の結果の機序について言及することは難しい．

本研究の限界点についてであるが，先ず，心拍数は服薬や心疾患などにより影響を受けため，それらのケースを排除して解析を実施することが望ましい[7]．しかし，高齢者は降圧剤使用や不整脈などのケースが非常に多く，本研究では，降圧剤使用者，不整脈者などは除かず，分析にあたっては調整因子として降圧剤使用の有無，さらに，健診における心電図所見を投入した上で解析を行った．

次に，対象地域では1996年から栄養に関する介入事業を実施し，介入により地域の栄養状態は改善している．このことをふまえると保健行動の変化による体力レベルの変化も考えられるが，介入の内容は一部の高齢者に講話を開くなど軽度なため，本研究における解析ではその影響はわずかであると考えられる．

また，運動強度についてであるが，本研究で用いた運動習慣は，面接調査において回答者本人が「運動」と自覚するものとし聞き取りを実施した．本研究では，散歩・体操についても「ふだん散歩や軽い体操をしていますか」と別項目で聞き取りしているが，本研究の「運動習慣」には含まれていない．同地区を対象に実施された先行研究[31]によると，聞取り調査から「散歩・体操」群，「スポーツ」群，「運動なし」群を分類し，各種運動能力テストの結果を合算し算出された得点を比較している．その結果，「スポーツ」群でその得点は最も高く，「運動なし」

群と「散歩・体操」群では，有意な相違がみられないことが報告されている．これらの結果から，本研究における「散歩・体操習慣」は体力に影響しない強度と判断し，身体活動の強度を一定レベル以上にするため「運動習慣」には含まずに解析を行った．

また，運動の内容であるが，1992年の運動の内容は87%がゲートボールであり，半数が週に2～4日の運動頻度であると報告されている[31]．このように，本研究の運動は，種目，強度，頻度ともに一定ではないが，運動の効果が確認され，長期的な運動の継続がその後の心拍数の増加を抑制したことが考えられる．

V．結　　語

本研究の結果，女性のみで長期的な運動の継続はその後の心拍数に影響し，運動の効果は比較的長期にわたり持続することを示していた．地域に在住する高齢者を対象にした健康促進活動の展開には，運動は欠かせない取り組みの一つである．本研究の結果は，心拍数を指標とした高齢期の健康の維持には運動が重要であることを再現し，高齢期の健康の維持には運動を積極的に取り入れていくことの重要性を示すものであった．また一方で，女性で認められた運動の効果が男性ではみられないことから，男性高齢者においては一定強度以上の運動実施が必要であることが考えられた．本研究で得られた心拍数を指標とした運動習慣の影響については，今後介入研究により検証していく必要がある．

謝　辞

本研究は東京都老人総合研究所プロジェクト「中年からの老化予防総合的長期追跡研究」の一環として行われた．本研究の実施にあたり秋田県南外村の皆様，また，東京都老人総合研究所疫学・福祉・政策研究グループ，地域保健研究グループの方々，他関係者各位に感謝申し上げます．

（受理日　平成17年5月16日）

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Effects of cognitive function on functional decline among community-dwelling non-disabled older Japanese

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Received 6 February 2005; accepted 1 June 2005
Available online 2 August 2005

Abstract

This study examined whether cognitive impairment, falls, and urinary incontinence (UI) were independent predictors of functional decline using a 2-year observation of a non-disabled older Japanese cohort living in a community from 1999 to 2001. A total of 139 men and 214 women aged 70–94 years at the baseline who were independent in both activities of daily living (ADL) and instrumental activities of daily living (IADL) were analyzed in this study. Independent variables, such as cognitive impairment, falls, UI, and other possible factors associated with functional decline were obtained from an interview survey at the baseline. A dependent variable was functional status in ADL and IADL obtained at the time of the 2-year follow-up. During the 2-year follow-up, cognitive function was a significant predictor for both IADL dependence and ADL and/or IADL dependence. Using a group of subjects with Mini Mental State Examination (MMSE) scores of 30–27 points as a reference group, a significant correlation was identified between lower MMSE scores and an increased odds ratio for functional decline. Lower cognitive function was a significant predictor of functional decline, even among those older Japanese whose cognitive function was deemed to be within the normal range.

Keywords: Instrumental activities of daily living; Aged; Cognitive impairment; Follow-up studies; Japan

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doi:10.1016/j.archger.2005.06.001

1. Introduction

The rapid rise in the number of older Japanese in recent years means that public health policies should pay particular attention to conditions and disorders unique to the elderly. Some of the most common disorders among the elderly persons defined as "old–old (aged 75 years and older)" are jointly referred to as geriatric syndrome, which generally includes senile dementia, urinary incontinence (UI), immobility, malnutrition, pressure sores, and iatrogenic disorders (Tinetti et al., 1995; Kane et al., 1999). Geriatric syndrome is known to diminish not only the long-term quality of life, but also the physical functioning in older people (Tinetti et al., 1995). Although several studies have examined whether cognitive impairment, falls, and/or UI are independent predictors of functional decline (Stuck et al., 1999; Aguero-Torres et al., 2002), few such studies have simultaneously assessed the prevalence of these conditions among community-living older adults to address the question of whether the latter are possible predictors of functional decline (Tinetti et al., 1995). Most studies dealing with the association between geriatric syndrome and functional decline use the activities of daily living (ADL) scale instead of the instrumental activities of daily living (IADL) scale as an outcome measure (Stuck et al., 1999); the latter provides an essential basis for determining whether an elderly individual is capable of living independently in the community (Aguero-Torres et al., 2002; Sauvaget et al., 2002). Measures for preventing dependence on IADL are expected to contribute to preventing ADL dependence because IADL dependence is a predictor of ADL dependence (Spector et al., 1987; Kai et al., 1991; Strawbridge et al., 1996; Nourhashemi et al., 2001). This is because individuals with IADL limitations are more likely to regain independence than those with ADL limitations (Crimmins and Saito, 1993; Ishizaki et al., 2000a, 2004). We therefore examined whether cognitive function, UI, experience of falls affected functional decline in either IADL only or ADL and/or IADL using a 2-year observation of a non-disabled older Japanese cohort living in a community.

2. Subjects and methods

2.1. Data source and study subjects

Following approval by the Institutional Review Board of the Tokyo Metropolitan Institute of Gerontology (TMIG), the study was conducted in a village in Akita Prefecture in the northern area of Honshu, one of the four main islands in Japan. In 2000, the total population of the village was 3538. A survey was taken first in 1999 and then again 2 years later. In the autumn of 1999, a face-to-face interview survey was carried out in a community center, for subjects with difficulty reaching the center, at their homes, to obtain baseline data. Because the questions in this study contained sensitive items, including UI and cognitive function, we were careful to protect participants' privacy by using screens between interviewer–participant pairs. Of the 786 people aged 70 years and older (320 men and 466 women) living in the village in 1999, 605 (77%) participated in the survey (256 men and 349 women). The vital status of the cohort was identified in 2001, using information for the residence registration records provided by the village government. Two

years after the baseline survey, and using the same method that had been used at the baseline, the subjects were surveyed again in relation to their survival status, ADL, and IADL. We limited the subjects of this particular study to those who were independent in both ADL and IADL at the baseline survey.

2.2. Assessment of functional status

ADL questions included walking, feeding, bathing, using the toilet, and dressing. IADL questions were derived from the instrumental self-maintenance scale of the TMIG index for competence (Koyano et al., 1991), and included going out using public transportation, shopping for daily necessities, preparing meals, paying bills, and depositing or withdrawing money from a bank account. The response to each item of these indices was simply "yes" (able to do without the help of another person or special equipment) or "no" (unable to do without the help of another person or special equipment). In this study, only those subjects who were assessed as being independent in all ADL (or IADL) items listed above were regarded as being ADL (or IADL)-independent. All other subjects were defined as ADL (or IADL)-dependent. Because the objective of this study was to examine the effects of geriatric syndrome on functional decline among older people during the 2-year follow-up period, we used functional status obtained from the follow-up survey conducted in 2001 as the outcome. Each subject's degree of functional independence at the time of the 2-year follow-up was categorized into the following three levels: independent in both ADL and IADL, dependent in only IADL, and dependent in ADL. In this study, functional decline was defined a change from independent in both ADL and IADL to either dependent in only IADL or dependent in ADL.

2.3. Assessment of geriatric syndrome

We collected information about the presence of UI, cognitive impairment, or experience of falls as geriatric syndrome. The questions regarding UI were related to the presence of UI and the frequency of incontinent episodes. The first UI question asked whether the subject had ever experienced urinary leakage before reaching a toilet. Answer choices for this question were: never, occasionally, and wearing diapers at all times. All subjects who chose alternatives indicating that they experienced urinary leakage occasionally or that they wore diapers at all times were questioned about the frequency of incontinence episodes. The answer choices were: almost daily, once every 2 days, once or twice a week, 1–3 times a month, and several times a year. Those subjects indicating that they experienced urinary leakage more than once a week were defined as having UI.

The Japanese version of the Mini Mental State Examination (MMSE) (Otsuka and Homma, 1991) was modified to evaluate the cognitive function of subjects living in a community (Folstein et al., 1985). The contents of the modified Japanese MMSE differ from the original in several ways. First, while the orientation question in the original version asks about the name and floor of the hospital where a respondent receives treatment, the same question in the modified version asks about the name of the community center where the interview was carried out. Second, the serial-sevens test, wherein the respondent starts with the number 100 and proceeds downward by subtracting seven each

time, was replaced by a backward spelling of the Japanese word "*FU-JI-NO-YA-MA*" (a five-syllable Japanese word "Mt. Fuji"). This substitution was made because of difficulty encountered explaining the rules of a serial-sevens test to both interviewers and respondents. Third, a copying task (copying of a complex figure) was given before a writing task because it was expected that many of the respondents in the present survey may not have immediately understood what exactly they were expected to write when asked to write a sentence. An MMSE score of 23 points or less and a score of 19 points or less were considered to be indicative of low cognitive skills and very low cognitive skills, respectively (McDowell and Newell, 1996).

The question regarding falls asked the subjects if they had experienced any falls during the past year. All subjects who had experienced falls were then asked about the frequency of falls during that period of time.

2.4. Potential predictors of functional decline

The interview also included questions regarding potential predictors of functional decline: age, gender, educational status, presence of visual impairment, presence of hearing impairment, intellectual activity, social role, and self-rated health. In terms of educational status, the subjects in the present study were divided into those with 6 years of education or less (elementary school level), and those with 7 years of education or more. A question about visual impairment was asked "Do you have any difficulties with visual activities?" The answer choices were: No, Yes, Yes with glasses. A question about hearing impairment was asked "Do you have any difficulties with hearing capability?" The answer choices were: No, Yes, Yes with a hearing device. Subscales derived from the TMIG index for competence (Koyano et al., 1991) were used to assess the subjects' intellectual activity (four items: filling out pension forms, reading a newspaper, reading books or magazines, and being interested in news stories or programs dealing with health) and social role (four items: visiting the homes of friends, being called on for advice, being able to visit sick friends, and initiating conversations with young people). A subject's intellectual activity and social role were defined as "good" only if a subject was assessed as being independent in all subscale items, and were defined as "poor" if a subject was assessed as being dependent in any of the subscale items. A question about self-rated health was asked "How would you rate your present health?" The answer choices were: good, fair, poor, and very poor. In this particular study, the self-rated health was categorized as either 'good' (good or fair) or 'poor' (poor or very poor).

2.5. Statistical methods

Functional and cognitive status of the subjects at the baseline survey were categorized according to the level of functional independence. Possible predictors of functional decline were examined by conducting the χ^2-test and a backward-stepwise multiple logistic regression analysis using either functional decline in only IADL or functional decline in ADL and/or IADL after 2 years (reference category: remaining independent in both ADL and IADL after 2 years) as a dependent variable, and presence of UI, cognitive function and experience of falls as explanatory variables. Other explanatory variables used included age,

gender, educational status, presence of hearing impairment, presence of visual impairment, self-rated health, intellectual activity, and social role. Whereas a P-value of 0.15 was used for variable retention for the backward-stepwise procedure, gender, age, cognitive function, presence of UI, and fall experience were always used as independent variables regardless of P values. The association between functional decline and possible predictors was assessed by odds ratio (OR) and 95% confidence interval (CI). We performed the goodness-of-fit tests developed by Hosmer and Lemeshow on the final model to measure how well the model fit the data (Hosmer and Lemeshow, 1989). A sensitivity analysis was conducted to determine the effects of drop-outs on the analysis results (Heitjan, 1997). Other sensitivity analysis was performed to examine the effect of the absence of the variable regarding educational attainment on the results. All analytical procedures were performed using SPSS Version 10.0 (SPSS Inc., 1999). All reported P values were two-tailed, and the level of significance was $P < 0.05$.

3. Results

3.1. Functional and cognitive status of the followed-up subjects at the baseline

Of all the subjects who participated in the 1999 baseline survey, a total of 526 (204 men and 322 women) provided answers for all question items related to functional abilities and the presence of geriatric syndrome. Of those, 81% (425 respondents) were assessed as both ADL- and IADL-independent, 14% were assessed as IADL-dependent only, and 5% were assessed as ADL-dependent.

The mean MMSE scores of 407 subjects who were both ADL- and IADL-independent at the baseline was 26.2 points (standard deviation = 3.6, median = 27, and range = 11–30). Table 1 illustrates the distribution of the subjects' MMSE scores, the proportion of subjects who experienced UI more than once a week, and the proportion of subjects who experienced falls during the past year.

3.2. Changes in functional independence during the 2-year interval

Those subjects who were both ADL- and IADL-independent at the baseline were examined for changes in functional independence during the 2-year period (Table 2). Because 18 of 425 subjects did not have a clear educational status, the following analyses were conducted among 407 subjects. Of the 407 subjects who were initially independent in both ADL and IADL (163 men and 244 women), two had died during the interval between the two surveys and 55 (29 men and 31 women) did not participate in the follow-up survey. Although we did not have the detailed information on the reason for the lost to follow-up among the cohort, we confirmed that the reason was neither migration nor death. Although the majority of the surveyed subjects maintained functional independence over the 2-year period, a certain degree of functional decline was observed among 11% of the male and female subjects. Less than half of the female subjects who were aged 80 years and older remained functionally independent over the 2-year period.

Table 1
Basic characteristics of subjects who were independent in both ADL and IADL in the baseline survey of 1999 ($n = 407$)

Basic characteristics		
Mean age (years)		74.9 (standard deviation 4.4)
Age range (years)		70–94
Age class (% ≥80)		15.5
Gender (% women)		60.0
Educational status (% 6 years or less)		88.9
Self-rated health (% poor)		20.1
Intellectual activity (% poor)		45.7
Social role (% poor)		35.1
Hearing impairment (% present)		7.9
Visual impairment (% present)		1.5
Geriatric syndrome		
Cognitive function: MMSE score (%)	30–27	51.6
	26–24	26.3
	23–20	17.4
	19–0	4.7
Presence of UI (% present)		9.3
Falls experienced during the past year (% present)		9.1

3.3. Relationship between functional decline and geriatric syndrome

Univariate analyses and a stepwise multiple logistic regression analysis were performed to compare subjects who were ADL- and IADL-independent in both 1999 and 2001 ($n = 304$) and those who were ADL- and IADL-independent in 1999 and either became IADL-dependent only in 2001 ($n = 37$) or became ADL-dependent in 2001 ($n = 9$). These analyses revealed that only MMSE score was significantly associated with functional decline after 2 years (Tables 3 and 4). As shown in Model 2 (Table 4), using a group of subjects with MMSE scores of 30–27 points as a reference group, the ORs for any functional decline after 2 years were estimated as 3.20 ($P = 0.015$), 5.66 ($P < 0.001$) and

Table 2
Functional transition over a 2-year period among Japanese elderly who were initially ADL- and IADL-independent at the baseline survey in 1999 ($n = 407$)

	Age group	Functional status in 2001				
		Independent in ADL and IADL (%)	Dependent in IADL only (%)	Dependent in ADL (%)	Dead (%)	Loss to follow-up (%)
Men	70–79 ($n = 135$)	75.6	9.6	0.7	0.0	14.1
	≥80 ($n = 28$)	60.7	10.7	3.6	0.0	25.0
	Total ($n = 163$)	73.0	9.8	1.2	0.0	16.0
Women	70–79 ($n = 209$)	82.3	3.3	2.4	1.0	11.0
	≥80 ($n = 35$)	37.1	40.0	5.7	0.0	17.1
	Total ($n = 244$)	75.8	8.6	2.9	0.8	11.9

Table 3
Results of univariate analyses that examined effects of geriatric syndrome on functional decline in IADL among Japanese elderly who were initially ADL- and IADL-independent over a 2-year period ($n = 350$)

Predictors	Category	n	Functional status in 2001			
			Independent in ADL and IADL (%)	Dependent in only IADL (%)	Dependent in ADL (%)	P-value[a]
MMSE score	30–27	185	95.1	4.9	0.0	<0.001
	26–24	91	85.7	12.1	2.2	
	23–20	61	73.8	18.0	8.2	
	19–0	13	38.5	46.2	15.4	
UI	Absent	317	87.1	10.1	2.8	0.432
	Weekly or daily	33	84.8	15.2	0.0	
Falls experienced during the past year	Absent	317	87.4	9.8	2.8	0.219
	Present	33	81.8	18.2	0.0	

[a] χ^2-test.

16.50 ($P < 0.001$) for groups of subjects with MMSE scores of 26–24 points, 23–20 points and 19–0 points, respectively (test for trend, $P < 0.001$). MMSE scores were also significantly associated with only IADL decline.

Table 4
Effect of cognitive function assessed by the MMSE on functional decline among Japanese elderly who were initially independent in both ADL and IADL during the 2-year interval, 1999–2001

Predictors	Category	Model 1[a] ($n = 341$)			Model 2[b] ($n = 350$)		
		OR	95% CI	P-value	OR	95% CI	P-value
MMSE score	30–27	1.00			1.00		
	26–24	2.65	0.99, 7.10	0.052	3.20	1.25, 8.20	0.015
	23–20	3.51	1.25, 9.86	0.017	5.66	2.19, 14.64	<0.001
	19–0	13.29	2.69, 65.79	0.002	16.50	3.68, 73.96	<0.001
			Test for trend	<0.001		Test for trend	<0.001
UI	Absent	1.00			1.00		
	Weekly or daily	1.30	0.38, 4.40	0.673	1.84	0.56, 6.07	0.317
Falls experienced during the past year	Absent	1.00			1.00		
	Present	0.48	0.16, 1.42	0.184	0.59	0.20, 1.73	0.331
Hosmer–Lemeshow test		$\chi^2 = 2.59$ ($P = 0.957$)			$\chi^2 = 3.30$ ($P = 0.914$)		

[a] Model 1: Stepwise multiple logistic regression analysis was performed to compare subjects who were ADL- and IADL-independent in both 1999 and 2001 ($n = 304$) and those who were ADL- and IADL-independent in 1999 and became dependent in only IADL in 2001 ($n = 37$). The OR was adjusted for gender, age, and educational status.

[b] Model 2: Stepwise multiple logistic regression analysis was performed to compare subjects who were ADL- and IADL-independent in both 1999 and 2001 ($n = 304$) and those who were ADL- and IADL-independent in 1999 and became dependent in IADL and/or ADL in 2001 ($n = 46$). The OR was adjusted for gender, age, educational status, and social roles.

Table 5
Results of sensitivity analysis to examine effects of loss-to-follow-up and lack of educational information on functional decline over the 2-year period

Predictors	Category	Model 1[a] ($n = 405$)			Model 2[b] ($n = 363$)		
		OR	95% CI	P-value	OR	95% CI	P-value
MMSE score	30–27	1.00			1.00		
	26–24	1.86	1.03, 3.38	0.041	3.25	1.31, 8.08	<0.001
	23–20	2.98	1.54, 5.78	0.001	5.72	2.25, 14.51	<0.001
	19–0	8.84	2.69, 29.09	<0.001	21.44	5.13, 89.53	<0.001
			Test for trend	<0.001		Test for trend	<0.001
UI	Absent	1.00			1.00		
	Weekly or daily	1.44	0.60, 3.45	0.412	1.79	0.54, 5.87	0.339
Falls experienced during the past year	Absent	1.00			1.00		
	Present	0.86	0.37, 1.96	0.711	0.63	0.22, 1.84	0.400
Hosmer–Lemeshow test		$\chi^2 = 5.11$ ($P = 0.746$)			$\chi^2 = 7.33$ ($P = 0.501$)		

[a] Model 1: As a sensitivity analysis, subjects who were alive but did not participate in the follow-up survey were regarded as those who became dependent in IADL and/or ADL in 2001. Stepwise multiple logistic regression analysis was performed to compare subjects who were ADL- and IADL-independent in both 1999 and 2001 ($n = 304$) and those who were ADL- and IADL-independent in 1999 and either became dependent in IADL and/or ADL in 2001 ($n = 46$) or lost-to-follow-up in 2002 ($n = 55$). The OR was adjusted for gender, age, educational status, and social roles.

[b] Model 2: Other sensitivity analysis included subjects who did not have information about educational status ($n = 18$). Stepwise multiple logistic regression analysis was performed to compare subjects who were ADL- and IADL-independent in both 1999 and 2001 ($n = 315$) and those who were ADL- and IADL-independent in 1999 and either became dependent in IADL and/or ADL in 2001 ($n = 48$). The OR was adjusted for gender, age, and social roles.

3.4. Sensitivity analysis

Two kinds of sensitivity analyses (Table 5) were conducted to determine the effects of either drop-out or lack of information about educational status on the analysis results (Heitjan, 1997). First, we assumed that 55 subjects who did not participate in the follow-up survey were dependent in ADL and/or IADL and they were included in the multiple logistic regression analysis. Other sensitivity analysis was performed to examine the effect of not having information on educational attainment in the results. In both models, lower MMSE scores were significant predictors of functional decline and a statistically significant association was observed between lower MMSE scores and increased OR for functional dependence (test for trend, $P < 0.001$).

4. Discussion

This study examined whether cognitive impairment, falls, and UI were independent predictors for functional decline by means of a 2-year observation of a non-disabled older Japanese cohort living in a community from 1999 to 2001. Multivariate logistic regression

analysis revealed that cognitive function was a significant predictor for functional decline during the 2-year follow-up. Analysis also revealed that, using a group of subjects with MMSE scores of 30–27 points as a reference group, a significant association was found between lower MMSE scores and increased OR for functional decline. These results indicate that lower cognitive function was a significant predictor for functional decline even among those older non-disabled Japanese whose cognitive function was deemed to be within the normal range.

All subjects included in the analysis were both ADL- and IADL-independent at the baseline; nevertheless, lower MMSE scores were significantly associated with any decreased functional independence 2 years later. This result indicates that normal cognitive function as assessed by MMSE does not necessarily guarantee long-term functional independence, especially if the elderly concerned have lower than average MMSE scores. Several longitudinal studies point to dementia (Aguero-Torres et al., 1998; Sauvaget et al., 2002) and cognitive impairment (Moritz et al., 1995; Gill et al., 1996, 1997; Aguero-Torres et al., 1998) as predictors of decreased ADL-independence; others revealed dementia to be a predictor of decreased IADL-independence (Sauvaget et al., 2002). One study also indicated that elderly people with normal cognitive function, but lower MMSE scores, were likely to have decreased ADL independence in the future (Greiner et al., 1996). The present study is unique in that it examined whether lower cognitive function is a possible predictor for ADL and/or IADL decline and in that it indicates that elderly with normal cognitive function, but lower MMSE scores, are likely to have decreased functional independence in the future.

Several issues may need to be considered when addressing cognitive function as a possible predictor of decreased functional independence. According to Lawton's model (Lawton, 1972), IADL performance requires higher cognitive functioning than ADL performance, since IADL deals with execution of more complicated tasks. A person with low cognitive performance is considered to have limitations in performing IADL tasks, and is therefore at increased risk of impaired IADL. In our previous study, a survey carried out in another village targeted older adults who were both ADL- and IADL-independent at the baseline (Ishizaki et al., 2000b). In that study, poor intellectual activity was identified as a significant predictor for IADL decline among older ADL- and IADL-independent subjects; however, the subjects' cognitive functions were not measured. To compare the results from our previous study with the present study, cognitive function assessed by MMSE was excluded from a multiple logistic regression analysis in this study. The results indicated that poor intellectual activity was a significant predictor of IADL dependence in the follow-up 2 years, supporting the understanding that IADL requires a certain level of intellectual capacity.

In this study, the present of UI was not associated with functional decline. Most female subjects with UI who participated in this survey replied that they used a special pad for urinary leakage (data not shown). Thus, such women were able to maintain IADL despite having UI. The prevalence rate of UI in this study (10%) was lower that that of previous studies because subjects in this study were limited to those with any disability in both ADL and IADL, while previous epidemiological studies were included both non-disabled and disabled populations. When we added disabled subjects at the time of the baseline survey to the original analyzable subjects, the prevalence of UI was about 40%. In addition, when we

asked respondents about UI, we were careful to protect their privacy. Therefore, we can say that the effect of underreporting UI in this study was not significant.

In interpreting the study results, the following limitations must be considered. First, 10% of the participants at the baseline did not participate in the follow-up, and 10 of the followed-up subjects provided no answers to some of the key questions related to functional status and were therefore excluded from the analysis. The 55 subjects who were lost to follow-up were significantly more likely to have poor social role, to have hearing impairment, and to have visual impairment than the 350 analyzable subjects ($P < 0.05$, data not shown). Sensitivity analysis was conducted to determine the effects of drop-outs on the analysis results based on two assumptions. In all cases, lower MMSE scores were significant predictors of IADL dependence and a statistically significant association was observed between lower MMSE scores and increased OR for functional dependence ($P < 0.001$). It can therefore be concluded that the effects of drop-outs on the results of the analysis were relatively small. Second, although the MMSE score of an individual is known to vary greatly depending on his/her educational attainment, educational attainment was not included in the logistic model regardless of the sensitivity analysis. The result indicated that lower MMSE scores were still a significant predictor of functional dependence. Finally, the subjects in the present study were selected from an agricultural village in Japan, and they therefore do not represent the entire elderly population of the country. However, the elderly adults who participated in the baseline survey constituted 77% of all elderly aged 70 years and older living in the surveyed district; thus, our study represents at least the elderly population living within the village surveyed. Despite the limitations listed above, the present study reliably demonstrates that lower cognitive function is a significant predictor of increased functional dependence over a 2-year period among elderly Japanese whose cognitive function is deemed to be within the normal range and who are both ADL- and IADL-independent.

5. Conclusion

To prevent lifestyle-related diseases, such as cerebral stroke, heart attack, and cancer, among middle aged and older adults, every Japanese citizen aged 40 years and older is entitled to receive an annual health examination under the Health Care Law for the Aged (Nakahara, 1997). As the Japanese population is graying rapidly, we believe the annual health examination should also be used as a means either to detect or prevent functional decline among the elderly. In order to ensure functional independence among the elderly, health examinations for them should include regular assessment of functional and cognitive status (Rubenstein and Rubenstein, 1992; Ebrahim, 1999). If a person is both ADL- and IADL-independent, but is assessed as exhibiting relatively poor cognitive performance, such an individual should be examined more closely and followed up to ensure that both his/her functional and cognitive status are maintained or improved. We believe the findings in this study can be instrumental in promoting healthy changes and preventing functional decline among non-disabled older adults living in communities in Japan.

Acknowledgement

This study was supported in part by a Grant-in-Aid for Comprehensive Research on Aging and Health from the Ministry of Health, Labour and Welfare, Japan.

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第4次調査中間結果

MONOGRAPH

The Fourth Wave

June, 2004～May, 2005

National Institute for Longevity Sciences Longitudinal Study of Aging

NILS-LSA

I. Objectives and Overview of the NILS-LSA

II. Background Examinations

III. Medication

IV. Food and Nutrition

V. Bone Mineral Density

VI. Blood and Urine Analysis

VII. Psychological Examinations

VIII. Visual and Auditory Examinations

IX. Physiological Examinations

X. Physical Function Tests and Physical Activities

XI. Anthropometry and Body Composition

XII. Head MRI

XIII. Oral examinations

I. Objectives and Overview of the NILS-LSA

I. Objectives and Overview of the NILS-LSA

1) Background and outline of the NILS-LSA
2) Progress of the NILS-LSA
3) Objectives of the NILS-LSA
4) Research area
5) Subjects
6) Implementation of the study
7) Informed consent
8) Examinations and tests
9) Future of the NILS-LSA
10) Staff