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A Prospective Study of Frailty, Mortality and Required Level of Care in Elderly Requiring Support

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This study aimed to identify the risk factors related to insurance care diversion by elucidating how frailty is related to mortality and required level of care in the elderly. We conducted a baseline survey of disease, lifestyle and frailty. The analysis subjects were 60 elderly requiring support（the support level group）and 62 independent elderly（the independent group）. We then conducted a 4 year follow-up survey. Results showed that death in the support level group was significantly correlated with age ≥ 75 years, falls, male and physical exercise. In the independent group, death was significantly correlated with smoking and gait difficulty. Deterioration in required level of care in the support level group was significantly correlated with male and malnutrition. Death and deterioration were independent of disease and lifestyle and were associated with the frailty indicators falls, gait difficulty, and malnutrition for the required level of care in the individuals of the support level group. These results show that the need for preventive care services to focus on frailty prevention.

Key words: elderly, frail, mortality, requiring support

INTRODUCTION

The global population of elderly aged 65 years and above is expected to increase from 7.6% in 2010 to 18.3% in the next 50 years. Japanese society in particular is aging at an unparalleled speed, and in 2011 it became classed as a super-aging society, with the elderly population accounting for 23.3% of the total population. The increase in the number of elderly requiring care in this super-aging society prompted Japanese officials to establish a long-term care insurance system in 2000 [1, 2]. The number of individuals certified under this insurance system has risen year after year from an initial 2.18 million to 5.54 million in 2012, has tremendously increased the elderly requiring support. In particular, almost 26% of the elderly requiring support qualify for long-term care insurance（as of December 2012）.

Elderly requiring support are defined as those who are certified for support at level 1 or 2 under the long-term care insurance system, and whose physical or psychological impairment necessitates an estimated 25 minutes-50 minutes of support for activities of daily living（ADL）such as bathing, toileting and eating according to the qualification criteria for long-term care, but who are also deemed being mentally and physically stable and of sufficient mental capacity without dementia and other conditions to understand how to use the care diversion benefits. The care services provided to the elderly requiring support are called preventive care services. The aim of care services for the elderly requiring support is to improve the functioning and activities of daily living（ADL）of this group, rather than simply alleviating the burden on care. The insurance benefit that provides for this service is also known as the care diversion benefit. However, it has been pointed out that while appropriate care diversion services are effective at maintaining and improving ADL [3], overuse of these services can potentially lead to deterioration in ADL [4].

Frailty is associated with characteristics such as

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fall, gait difficulty, mild depression, being homebound, and malnutrition and these associated characteristics have received attention as factors necessitating support for the elderly. Frailty is present in 4%-27% of elderly living at home [5-7], and has been related to death due to sarcopenia [8], deterioration in ADL [9, 10], and decline in cognitive function [11], etc. It is therefore considered important to elucidate the relationship between frailty, mortality and required level of care in elderly requiring support, and to improve the content of care services on the basis of this knowledge.

However, there have been few prospective studies on frailty, mortality, and required level of care, and the research that exists has been limited by length of follow-up [12-14], subject bias [15, 16, 17], death as the only outcome [18], etc. In this study we therefore sought to elucidate the relationship between frailty, mortality and required level of care by conducting a prospective survey over a 4 year period targeting elderly requiring support and independent elderly matched for sex and age.

RESEARCH METHODS

Survey subjects

The elderly subjects requiring support (the support level group) were 75 elderly newly certified as requiring support at level 1 or 2 by the Unnan Wide Area Union between April and July 2007. The public nursing care insurance system covers all elderly aged 65 years or above who require physical or psychological care [1, 19]. The different categories of service level are based on a standardized format and the amount of service provided is measured [2]. The independent elderly subjects (the independent group) were 75 elderly residents of Unnan City who were matched for sex and age to the support level group. The independent group was selected the same age, same sex, and same residential area people to the support level group by Unnan city. The baseline survey was conducted in August 2007 by interview survey at each subject's home by public health nurses trained in the survey's contents and methodology. During the 4 year follow-up period, there were a total of 28 dropouts: 15 subjects in the support level group and 13 subjects in the independent group. Of the dropouts in the support level group, five moved away or entered an institution, eight withdrew consent and two had missing initial data. Of the dropouts among the independent group, one moved away, four withdrew consent and eight had missing initial data (Fig. 1). There were no significant differences in characteristics at baseline between dropouts and follow-up subjects.

The ethics committee of Shimane University Faculty of Medicine approved the survey and all subjects gave written consent to participate.

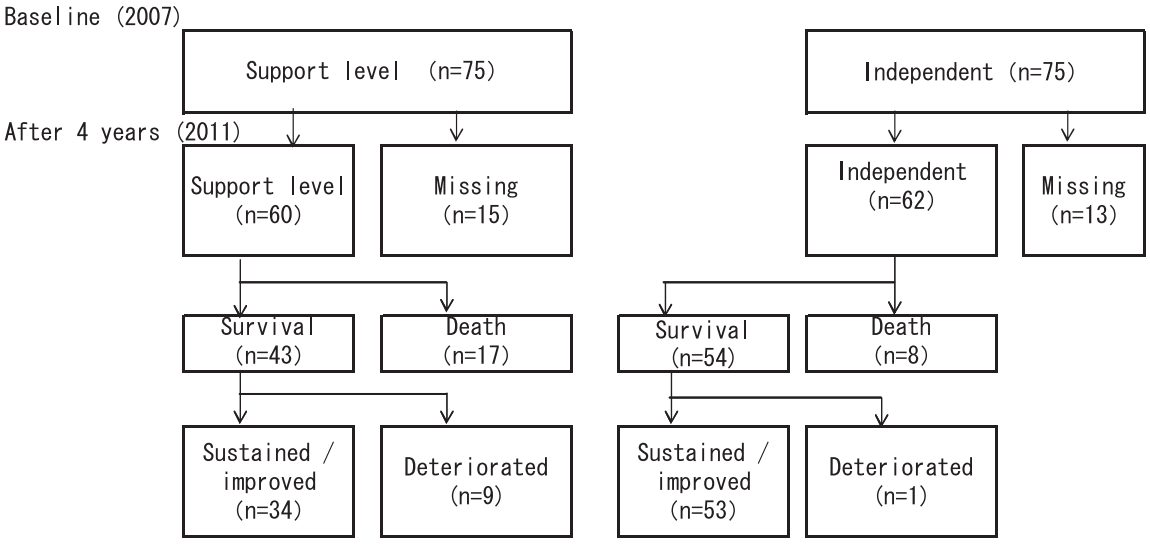

Fig. 1. Study profile of elderly requiring support or independence in Unnan City.

Survey items at baseline

The survey collected information regarding the following: sex, age, long-term care insurance certification, and disease (current and previous history of hypertension, heart disease, dementia, and fracture and knee osteoarthritis), lifestyle (physical activity, smoking, and drinking) and frailty (fall, gait difficulty, mild depression, homebound, and malnutrition). Public health nurses collected the data on sex, age, long-term care insurance certification, disease, lifestyles, and frailty from interview survey.

For the lifestyle section, subjects were considered to be undertaking physical activity if they engaged in physical activities such as walking, exercise, weight training, swimming, and jogging, etc. Subjects who currently smoked were defined as smokers. Subjects who regularly drank alcohol, regardless of the amount, were considered to be drinkers.

For the frailty section, subjects who had experienced a fall within the previous year were considered to have a fall, and those who felt restricted in their daily walking ability were considered to have gait difficulty. Subjects were considered to have mild depression if they agreed with one or more of the following five statements: I feel dissatisfied in my daily life; I no longer enjoy things that I used to enjoy; I feel annoyed by things that I used to do easily; I think I am a useless person; I feel fatigued without particular reasons. Subjects who did not leave the house more than once a week were considered to be homebound. Subjects with a body mass index (BMI) below 18.5 were considered to have malnutrition.

Outcome variables

The outcome variables were death and deterioration in required level of care after 4 years. Data on long-term care insurance certification and cause and time of death were collected from long-term care insurance certification information held by the Unnan Wide Area Union.

Deterioration in required level of care was defined as an increase to level 2 care or higher. Once care at this level becomes necessary, maintenance at this level or improvement are difficult and further deterioration is likely. Persons requiring level 2 support show a decline in instrumental daily activities and require intervention in some activities of daily living.

Statistical analysis

Fisher's exact probability test was used to compare the characteristics of the support level group and the independent group at baseline. We used a prospective cohort study design to investigate death and deterioration in required level of care after 4 years separately for each group. This was because both groups had different incidence rates of death and deterioration in required level of care, and different proportions of subjects with frailty as a baseline characteristic. Fisher's exact probability test was performed separately for the support level group and the independent group to analyze the factors related to death and deterioration in required level of care after 4 years. Odds ratios and 95% confidence intervals (CI) were then calculated using bivariate logistic regression analyses (stepwise, backward conditional) to analyze independent correlations between frailty at baseline, death and deterioration in required level of care. Sex, age, disease, and lifestyle were included as covariates in the analyses. This method was not used for the independent group because only one subject showed deterioration in required level of care. Dementia and smoking in the support group and dementia and being homebound in the independent group were also omitted from the related factors because they were each present in fewer than five subjects. A two-tailed p value of <5% was set as the significance level. IBM SPSS Statistics Version 20 (IBM; Tokyo) was used to perform the statistical analysis.

RESULTS

Subject characteristics at baseline

Follow-up rate of 5 years were that the support level group was 80.0% and the independent group was 82.7%.

At the baseline, a comparison of the characteristics of the support level group and the independent group found no statistically significant regarding the differences between sex, age, current and previous history of heart disease and hypertension, physical activity, smoking, BMI, and fall.

However, the support level group had significantly more frailty-related characteristics than the independent group (Table 1). 50 (83.3%) subjects in the

support level group had gait difficulty, which was significantly higher than the 21 (33.9%) of the independent group subjects. Similarly, 28 (46.7%) subjects in the support level group had mild depression and 18 (30.0%) were homebound. These were significantly higher proportions than in the independent group subjects. In contrast, there were no significant differences in fall and malnutrition between the support level group and the independent group. There were also significantly fewer drinkers (eight; 13.3%) in the support level group compared to the independent group (19; 30.6%) (Table 1).

Comparison of death and deterioration in required level of care in the support level group and the independent group

After 4 years, nine (20.9%) the support level group showed deterioration in required level of care. This was significantly more than the one (1.9%) in the independent group ($p = 0.004$). The odds ratio was 14.03 (95% CI: 1.70-115.76) (Table 2). The most common causes of death in the support level group were cancer, renal failure and heart failure, each accounting for three deaths, followed by two deaths from respiratory failure and one death each

Table 1. Characteristics of elderly requiring support or independence at the baseline

Factor	Variables	Response category	Support level (n = 60)	Independent (n = 62)	p − value
Demographic characteristics					
	Gender	Man	19 (31.7)	22 (35.5)	0.566
	Age	≦74 years	10 (16.7)	8 (12.9)	0.616
Disease					
	Hypertension	Yes	38 (63.3)	37 (59.7)	0.713
	Heart disease	Yes	16 (26.7)	11 (17.7)	0.279
	Dementia	Yes	1 (1.7)	0 (0.0)	1.000
	Fracture	Yes	11 (18.3)	9 (14.5)	0.461
	Knee osteoarthritis	Yes	15 (25.0)	13 (21.0)	0.669
Lifestyle					
	Physical activity	Yes	37 (61.7)	38 (61.3)	1.000
	Smoking	Yes	2 (3.3)	5 (8.1)	0.440
	Drinking	Yes	8 (13.3)	19 (30.6)	0.029
Frailty					
	Fall	Yes	19 (31.7)	15 (24.2)	0.421
	Gait difficulty	Yes	50 (83.3)	21 (33.9)	＜0.001
	Mild depression	Yes	28 (46.7)	8 (12.9)	＜0.001
	Homebound		18 (30.0)	3 (4.8)	＜0.001
	Low weight	BMI＜18.5	14 (23.3)	15 (24.2)	1.000

Data are given as number (%). The p value was calculated using Fisher's exact test for categorical.
Abbreviations: BMI; body mass index.

Table 2. Incidence of mortality and deterioration of level of care by requiring support or independence

Out come	Response category	Support level (n = 60)	Independent (n = 62)	OR	95 % CI	p − value
Death	Survival	43 (71.7)	54 (87.1)	2.67	(1.052 - 6.770)	0.044
	Death	17 (28.3)	8 (12.9)			
Certification level of care	Sustained / Impreved	34 (79.1)	53 (98.1)	14.03	(1.700 - 115.763)	0.004
	Deteriorated	9 (20.9)	1 (1.9)			

Data are given as number (%). The p value was calculated using Fisher's exact test for categorical. variables
Sample of level of care is the only survivor
Abbreviations: OR ; Odds ratio, CI ; confidence interval

from acute hypoglycemia, hypothermia, cerebral infarction, septicemia, and pneumonia. The most common cause of death in the independent group was cancer, accounting for six deaths, followed by one death from heart failure and one death from pneumonia. Overall there were 17 (28.3%) deaths in the support level group. This was significantly more than the eight (12.9%) deaths in the independent group. The odds ratio was 2.67 (95% CI: 1.05-6.77).

Factors related to death

Table 3 shows the analysis of factors related to death in the support level group and the independent group.

In the support level group, there were significantly more deaths in men (nine; 52.9%) than in women (nine; 47.1%) (p = 0.03). There tended to be more deaths among subjects aged 75 years or above than those aged 74 years or below. Among lifestyle characteristics, there tended to be more deaths in subjects who did not exercise, although the difference was not significant. Among frailty characteristics, more deaths tended to be associated with fall and being homebound. There were, however, no significant differences in gait difficulty, mild depression and malnutrition.

In the independent group, there were significantly fewer deaths in smokers (three; 37.5%) than in non-smokers (five; 62.5%). There were no significant differences in any other factors.

Predictive factors for death detected by bivariate logistic regression analysis were age, physical exercise, sex and fall in the support level group, and gait difficulty and smoking in the independent group. In the support level group, the odds ratios for death were 20.19 (95% CI: 1.46-278.60) in subjects aged 75 years or above, 4.57 (95% CI: 1.15-18.17) in men, and 4.82 (95%CI: 1.07-21.73) for fall. Lack

Table 3. Mortality associated with the characteristics at baseline

Factor	Variables	Response category	Support level			Independent		
			Survival (n = 43)	Death (n = 17)	p − value	Survival (n = 54)	Death (n = 8)	p − value
Demographic characteristics								
	Gender	man	9 (20.9)	9 (52.9)	0.03	18 (33.3)	4 (50.0)	0.44
		woman	34 (79.1)	8 (47.1)		36 (66.7)	4 (50.0)	
	Age	≦74 years	9 (20.9)	1 (5.9)	0.26	7 (13.0)	1 (12.5)	1.00
		75 years ≦	34 (79.1)	16 (94.1)		47 (87.0)	7 (87.5)	
Disease								
	Hypertension	Yes	27 (62.8)	11 (64.7)	1.00	34 (63.0)	3 (37.5)	0.25
		No	16 (37.2)	6 (35.3)		20 (37.0)	5 (62.5)	
	Heart disease	Yes	9 (20.9)	7 (41.2)	0.19	10 (18.5)	1 (12.5)	1.00
		No	34 (79.1)	10 (58.8)		44 (81.5)	7 (87.5)	
	Fracture	Yes	8 (18.6)	2 (11.8)	0.71	6 (11.1)	2 (25.0)	0.273
		No	35 (81.4)	15 (88.2)		48 (88.9)	6 (75.0)	
	Knee osteoarthritis	Yes	12 (27.9)	3 (17.6)	0.52	12 (22.2)	1 (12.5)	1.000
		No	31 (72.1)	14 (82.4)		42 (77.8)	7 (87.5)	
Lifestyle								
	Physical activity	Yes	29 (67.4)	8 (47.1)	0.24	35 (64.8)	3 (37.5)	0.24
		No	14 (32.6)	9 (52.9)		19 (35.2)	5 (62.5)	
	Smoking	Yes	2 (4.7)	0 (0.0)	1.00	2 (3.7)	3 (37.5)	0.01
		No	41 (95.3)	17 (100.0)		52 (96.3)	5 (62.5)	
	Drinking	Yes	4 (9.3)	4 (23.5)	0.21	16 (29.6)	3 (37.5)	0.69
		No	39 (90.7)	13 (76.5)		38 (70.4)	5 (62.5)	
Frailty								
	Fall	Yes	11 (25.6)	8 (47.1)	0.13	12 (22.2)	3 (37.5)	0.39
		No	32 (74.4)	9 (52.9)		42 (77.8)	5 (62.5)	
	Gait difficulty	Yes	35 (81.4)	15 (88.2)	0.71	17 (31.5)	4 (50.0)	0.43
		No	8 (18.6)	2 (11.8)		37 (68.5)	4 (50.0)	
	Mild depression	Yes	21 (48.8)	7 (41.2)	0.78	7 (13.0)	1 (12.5)	1.00
		No	22 (51.2)	10 (58.8)		47 (87.0)	7 (87.5)	
	Homebound	Yes	11 (25.6)	7 (41.2)	0.35	2 (3.7)	1 (12.5)	0.34
		No	32 (74.4)	10 (58.8)		52 (96.3)	7 (87.5)	
	Low weight	BMI＜18.5	9 (20.9)	5 (29.4)	0.51	13 (24.1)	2 (25.0)	1.00
		BMI≧18.5	34 (79.1)	12 (70.6)		41 (75.9)	6 (75.0)	

Data are given as number (%). The p value was calculated using Fisher's exact test for categorical.

Abbreviations: BMI ; body mass index.

of physical exercise also tended to be significantly associated with death in the support level group, with an odds ratio of 3.34 (95% CI: 0.85-13.14). In the independent group, the odds ratios for death were 52.50 (95% CI: 3.62-761.44) in smokers, and 8.24 (95% CI: 0.85-79.44) in those with gait difficulty, which was a significant trend (Table 4).

Factors related to deterioration in required level of care after 4 years

Table 5 shows the analysis of factors related to deterioration in required level of care in the support level group.

Significantly more subjects with knee osteoarthritis than those without showed deterioration in required level of care ($p = 0.04$). Similarly, significantly more subjects with BMI below 18.5 (i.e., malnutrition) showed deterioration in required level of care than those with BMI of 18.5 or above ($p = 0.04$). There were no other significant differences in disease, lifestyle or frailty.

The bivariate logistic regression analysis detected malnutrition and sex as factors predicting deterioration in the support level group. The odds ratios for deterioration in required level of care compared to maintenance or improvement in the support level group were 0.03 (95% CI: 1.85-473.87) in those with BMI < 18.5, and 75.15 (95% CI: 3.56-1585.81) in males, which was a significant trend (Table 6).

DISCUSSION

This study showed that the support level group had a higher mortality rate and deterioration in required level of care after 4 years than the independent group. Previous research has shown that the risk of death and deterioration in required level of care increases in elderly as the required level of support increases [20, 21], and that elderly requiring support tend to have a higher mortality rate than the independent elderly [3, 22]. Furthermore, our study further demonstrated that death and deterioration in required level of care are more likely to occur for the requiring level of care in the elderly with mild impairments requiring daily care for only short periods of time as demonstrated by the long-

Table 4. The predictions for death by logistic regression analysis

Group	Variables	Response category	OR	95 % CL	*p* − value
Support level	Gender	Women		Reference	
		Men	4.57	(1.15 − 18.17)	0.031
	Age	≦ 74 years		Reference	
		75 years ≦	20.19	(1.46 − 278.60)	0.025
	Physical activity	Yes		Reference	
		No	3.34	(0.85 − 13.14)	0.085
	Fall	No		Reference	
		Yes	4.82	(1.07 − 21.73)	0.041
Independent	Smoking	No		Reference	
		Yes	52.50	(3.62 − 761.44)	0.004
	Gait difficulty	No		Reference	
		Yes	8.24	(0.85 − 79.44)	0.068

Using stepwise decline analysis method.

Abbreviations: OR ; Odds ratio, CI ; confidence interval.

Support level analyzed variables included gender, age, hypertension, heart disease, fracture, knee osteoarthritis, physical activity, drinking, fall, gait difficulty, mild depression, house bound, low weight.

Independence analyzed variables included gender, age, hypertension, heart disease, fracture, knee osteoarthritis, physical activity, smoking, drinking, fall, gait difficulty, mild depression, low weight.

Table 5. Care level associated with the characteristics of support level at baseline

Factor	Variables	Response category	Sustained / Impreved (n = 34)	Deteriorated (n = 9)	p − value
Demographic characteristics					
	Gender	Man	4 (11.8)	5 (55.6)	0.14
		Woman	30 (88.2)	4 (44.4)	
	Age	≦74 years	8 (23.5)	1 (11.1)	1.00
		75 years ≦	26 (76.5)	8 (88.9)	
Disease					
	Hypertension	Yes	22 (64.7)	5 (55.6)	1.00
		No	12 (35.3)	4 (44.4)	
	Heart disease	Yes	7 (20.6)	2 (22.2)	0.41
		No	27 (79.4)	7 (77.8)	
	Fracture	Yes	9 (26.5)	0 (0.0)	0.17
		No	25 (73.5)	9 (100.0)	
	Knee osteoarthritis	Yes	12 (35.3)	0 (0.0)	0.04
		No	22 (64.7)	9 (100.0)	
Lifestyle					
	Physical activity	Yes	23 (67.6)	6 (66.7)	0.73
		No	11 (32.4)	3 (33.3)	
	Smoking	Yes	2 (5.9)	0 (0.0)	1.00
		No	32 (94.1)	9 (100.0)	
	Drinking	Yes	4 (11.8)	0 (0.0)	0.12
		No	30 (88.2)	9 (100.0)	
Frailty					
	Fall	Yes	10 (29.4)	1 (11.1)	0.44
		No	24 (70.6)	8 (88.9)	
	Gait difficulty	Yes	28 (82.4)	7 (77.8)	1.00
		No	6 (17.6)	2 (22.2)	
	Mild depression	Yes	16 (47.1)	5 (55.6)	0.15
		No	18 (52.9)	4 (44.4)	
	Homebound	Yes	9 (26.5)	2 (22.2)	0.62
		No	25 (73.5)	7 (77.8)	
	Low weight	BMI < 18.5	5 (14.7)	4 (44.4)	0.04
		BMI ≧ 18.5	29 (85.3)	5 (55.6)	

Data are given as number (%). The p value was calculated using Fisher's exact test for categorical.
Abbreviations: BMI ; body mass index.

Table 6. Predictions about the deterioration of the level of care by logistic regression analysis

Group	Variables	Response category	OR	95% CL	p − *value*
Support level	Gender	Women		Reference	
		Men	75.15	(3.56 − 1585.81)	0.003
	Low weight	BMI ≧ 18.5		Reference	
		BMI < 18.5	29.62	(1.85 − 473.87)	0.017

Using stepwise decline analysis method.

Abbreviations: OR = Odds ratio, CI = confidence interval; BMI=body mass index.

Support level analyzed variables included gender, age, hypertension, heart disease, fracture, knee osteoarthritis, physical activity, drinking, fall, gait difficulty, mild depression, house bound, low weight.

term care insurance criteria. The 2005 revision of the Long-Term Care Insurance Act promoted a shift to a system emphasizing care diversion because existing services for people with mild impairments were not leading to improvements. Consequently the existing services were replaced by support services in which newly established regional support centers created care diversion plans based on the condition of elderly requiring support, and encouraged elderly to use their own skills and abilities in their daily lives. However, the short-term effects of care diversion are hard to confirm [24], and there is no established method for setting up or evaluating care diversion plans. Our study showed that elderly requiring support are at a high risk of death and deterioration in required level of care. Therefore, hese results show that the elderly requiring support have a high risk of death and deterioration for the required level of care and highlights the need for preventive care services to focus on frailty prevention.

The study focused on frailty, and was associated characteristics of fall risk, gait difficulty, mild depression, being homebound and malnutrition, and analyzed risk factors for death and deterioration in required level of care using a prospective study design. The results showed that frailty and lifestyle contributed to death and deterioration in required level of care, independent of disease, in both the support level group and the independent group, and that disease was not a risk factor in either subject group. Until now the discussion of death [24, 25] and deterioration in required level of care [26] among the elderly has mainly focused on disease. As a result, there has been much interest in death prevention and care strategies for the elderly from the perspective of different diseases, with little attention given to frailty [27].

The characteristics of frailty that were risk factors for death were fall in the support level group and gait difficulty in the independent group. Because exercise habits, fall risk and incidence of fractures and knee osteoarthritis were similar in both the support level group and the independent group, the gradual decline in walking ability with age is a problem shared by both subject groups. According to Shinkai *et al*., walking speed is a good predictor of impairment of instrumental activities of daily living in the elderly [28]. This shows that it is important for the elderly to maintain walking ability while living independently. A marked fall in walking speed and decline in activity have also been related to death in the elderly [29]. Because of the decline in walking ability and instrumental activities of daily living (IADL) the elderly also tend to miss out on opportunities to participate in leisure activities and other aspects of social life. In particular, the elderly requiring support are often housebound and depressive. For the elderly, whether they require some support or are fully independent, maintaining that the level of independence requires strategies such as maintaining the functional ADL and remaining socially active through regular leisure activities that promote the maintenance of walking ability.

Malnutrition as a characteristic of frailty was related to deterioration in required level of care in the support level group. BMI has previously been identified as a risk factor in obesity-related morbidity and death [30], but one in four elderly are at risk of malnutrition [31], which can easily lead to disease and death. Malnutrition and body weight decrease are thus effective predictors for death [32-34], and are also known to lead to impairment in leg mobility. Improving nutrition to prevent malnutrition is thus an important frailty prevention strategy for the elderly.

Among lifestyle characteristics, smoking was identified as a risk factor for death in the independent group. Because the independent group has maintained the functions of daily life at a higher level than those requiring support and are less affected by frailty, lifestyle factors would be expected to have a bigger impact. Cancer was the most common cause of death in the independent group, followed by heart failure. Smoking is known to increase the incidence of ischemic disease and cancer and the risk of death more than any other lifestyle factor, and our results similarly reflect this influence.

A limitation of this study was that the sample size was small, being restricted to a geriatric population in one Japanese municipality, and selection bias was a possibility. However, the long-term care insurance certification rate was 16.8%, which was the same as the certified proportion of the national population. The proportion of certified people re-

quiring care at each level also followed the same distribution, and the causes of death in Unnan City showed the same trend as in Japan as a whole. It is also significant that this was a comparison study targeting elderly subjects requiring support who were new applicants for long-term care at baseline, matched for sex and age with independent elderly subjects, and that the study clarified the contribution of frailty through analysis of not only death but also level of required care as the primary outcomes.

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