Yonago Acta medica 2006;49:93–101

Risk Factors for Death among the Functionally Independent Elderly Living in Japan: A 3-Year Prospective Cohort Study

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To examine risk factors for death in Japanese elderly men and women who live ordinary lives in a community, we performed a prospective cohort study in Kishimoto Town, Tottori Prefecture, Japan. In September 2001, the town population of the elderly who were 65 years and older and who lived functionally independently with or without family was 1383. We delivered questionnaires to them, and collected 1313 (94.9%) answers. Of the 1313, 29 were highly suggestive to dependent living. Subjects of the baseline survey consisted of 1284 independent elderly, excluding the 29. The subjects themselves reported answers to our questionnaire items concerning demographic variables (age, family), history of disease, homebound condition (place of daily activities), activity of daily living (walking, excreting), lifestyle (tobacco), psychology and mental status (subjective health), quality of life (domestic role) and physical status (body pain, experience of falling). They were followed-up for 3 years until August 2004. We examined correlations between their deaths during the follow-up (total number of deaths, 79: 49 men and 30 women) and potential factors for death using the Cox proportional hazard model. By the multivariate analysis of these variables, we observed that elderly men had four risk factors for death: age (hazard ratio and 95% confidence interval; 1.09 and 1.04–1.14), subjective health (2.45 and 1.40–4.30), domestic role (2.21 and 1.22–4.01) and tobacco (1.96 and 1.10–3.48). Elderly women had two risk factors, age (1.13 and 1.07–1.20) and physical ability or skill in handling banking duties (one of competence indexes for elderly activities of daily living) (2.45 and 1.12–5.39). Most noticeably, in the present elderly Japanese living functionally independently, death was significantly correlated with psychosocial factors (subjective health, domestic role) rather than physical factors (restriction of going outside due to incontinence).

Key words: community; death; independent elderly; prospective cohort study; risk factor

The average life expectancy for Japanese people was 78.36 years for men and 85.33 years for women in 2003 (Japan Health and Welfare Statistics Association, 2004). According to the statistics, Japanese females have retained the highest average in the world for about 20 successive years. For both men and women, Japan is one of the remarkable countries for longevity in the world (Japan Health and Welfare Statistics Association, 2004). The Japanese life span may have a further

Abbreviations: ADL, activity of daily living; IADL, instrumental ADL; QOL, quality of life: TMIG, Tokyo Metropolitan Institute of Gerontology; WHO, World Health Organization

prolonging tendency in the future, as well. As a result of their long life, the tendency toward an aged society has progressed more rapidly in Japan than in other countries. According to the definition created by the United Nations, when the rate of the 65-year-old or older population (aging rate) exceeds 7%, the society is aging and when the rate exceeds 14%, the society is aged. In other countries, the length of time that it took for an aging society to become aged was 115 years for France, 85 years for Sweden and 73 years for the United States. However, for Japan, the time it took to reach the "aged" status (from 7% in 1970 to 14% in 1994) was 24 years. In addition, our aging rate reached 19.5% in 2004, and aging still goes on very rapidly. According to recent statistics of the Japanese population, a more than 35% increase in aging is anticipated in 2050 (Ministry of Health, Labour and Welfare of Japan, 2005).

Until the middle of the twentieth century, the leading cause of death in Japan was infectious diseases, such as tuberculosis. But after that, the cause has completely changed into non-communicable chronic diseases (Japan Health and Welfare Statistics Association, 2004). In studying the vital prognosis of the elderly in developed countries, we should consider not only the effects of physical health but also their ability to lead a good life everyday, as well as the effects on their quality of life (QOL) reflecting their satisfaction or happiness. Health was defined in the Constitution of the World Health Organization (WHO) as a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity (WHO, 1946). The concept or definition of QOL is still vague and no precise agreement for its definition has yet been obtained. But the WHO's health definition today seems to be accepted by most researchers as the best so far. Covering the many research fields of psychology, sociology or gerontology, the main accepted indicators for estimating QOL are subjective health, subjective well-being (Larson, 1978), pleasure, life satisfaction and morale (Lawton, 1975). These are personal subjectivity-based indicators, and sometimes interpreted as the same things (Palmore, 2002). Particularly, subjective health is a reliable indicator of general health for the elderly, reflecting both physical health and socio-psychological soundness (Menec et al., 1999).

To our knowledge, workers have rarely investigated risk factors for death in Japanese elderly living functionally independently in communities. For the present survey, we defined "independent elderly persons" as those who were not caretakers as approved by the long-term care insurance system of Japan. At the same time, there were those who did not mark "dependent" on any of five ADL items at the baseline: walking, eating a meal, excreting, taking a bath and getting dressed. We utilized several indices based on objective and subjective measures, and studied their relationships to death: medical history, physical functions and ability to live an ordinary life were objectively available, and QOL factors were subjectively evaluated. Our aim was to clarify the physical and psychosocial risk factors for death through a 3-year prospective cohort study for the elderly men and women independently living in a community of Japan.

Subjects and Methods

Study population

The present prospective cohort study was performed in a community of western Japan, Kishimoto Town (now incorporated into Hoki Town), Tottori Prefecture. Kishimoto covers an area of 39.09 km^2, has a population of 7439, with the 2071 households (data as of 1 September 2001). Kishimoto's population of aged people exceeding 65 years of age was 22.6% in 2001, which was higher than the national level in 2000, 17.4%. The number of caretakers approved by town was 249. The entry criterion for the present study was the number of independent residents in Kishimoto as of 1 September, 2001 aged 65 and over. The total study population at baseline was all 1383 elderly

residents. From the start of the baseline survey, this cohort was followed-up between September 2001 and August 2004, 3 years at most. We determined the end point of the study for individual persons to be the occurrence of death during the period. That is, each follow-up period was from September 2001 to the earliest day of the following 3 years: day of death, day of moving out of the home or 31 August 2004. All cases of death and moving out during the period were confirmed by the national local resident registration system.

In September 2001, the questionnaires were distributed by district welfare commissioners or members, filled and sealed by the respondents and collected by each distributor. Considering the ethics of the baseline survey, the questionnaire was accompanied with a written explanation of the purpose of the survey, strict observance of their privacy and a statement of free-will to participate in the survey. Furthermore, the distributors orally informed the subjects of the above descriptions when they distributed the form. We made sure that informed consent was obtained from the subjects when they signed, sealed and delivered the form to their distributors. To conserve personal information, their names were coded by one of the authors (MM), the only one who was allowed to see the subjects' names, and coded data were carefully handled only by the other authors. This study was approved by the Tottori University Faculty of Medicine Committee for Ethics. The Kishimoto Town Office strictly obeyed the individual information protection enforcement regulations. To the 1383 questionnaires delivered, 1313 elderly replied (answer rate 94.9%). Of those, 29 were "dependent" in some way according to the five ADL items: walking; taking a meal; excreting; taking a bath; and getting dressed. However, the 29 had not yet applied for the long-term care insurance system at the town office. Because they were highly likely to live dependently, we excluded them from the survey and the remaining 1284 people were observed as follow-up subjects.

Study items

The study items at baseline generally covered physical, psychological and social characteristics of the elderly, which all were reported by subjects themselves. Firstly, demographic variables were asked such as gender, age and family constitution. The study items included three about homebound conditions: that is, ability of going out (Imuta et al., 1998), frequency of going out (home or out) (Haga, 2001; Ahiko, 2003). Their instrumental activities of daily living (IADLs) were evaluated with the TMIG Index of Competence subscales questionnaires which were developed by the Tokyo Metropolitan Institute of Gerontology (Koyano et al., 1984, 1987). The Index consisted of 13 items classified under three subscales of instrumental self-maintenance, intellectual activity and social role. Subjects were asked to answer yes/no or I can/I cannot. As an index of cognitional function, the presence of forgetfulness was asked. Quality of life (QOL), psychological and mental status were examined through subjective health, hobby or pleasure, best friends, reasons for living, subjective well-being and domestic role. Subjective health was evaluated by their answer which they chose from the following four, "excellent, good, fair or poor" to "how would you rate your health". Physical status considered to be highly related to death or dependent living was dysfunction of hearing and visual acuity; falling experience within the past year; pain in the upper or lower half of the body; restriction on going out due to incontinence; and degree of chewing force. History of chronic diseases was asked on seven classifications: stroke; heart disease; diabetes mellitus; fracture or osteoporosis; joint symptom or rheumatism; Parkinson's disease; mental disease, psychoneurosis or dementia. Other items studied were tobacco and community activities.

Statistical analysis

Mortality by gender was analyzed by the chi-square test. The independent variables used were

Table 1. Number of deaths in the follow-up subjects during 3 years

Age (year)	Men			Women			*P* value
	Number		%	Number		%	
	Subjects	Death	Mortality	Subjects	Death	Mortality	
65–74	239	15	6.3	288	2	0.7	< 0.001
≥ 75	290	34	11.7	467	28	6.0	< 0.006
Total	529	49	9.3	755	30	4.0	< 0.001

Chi-square test was used to analyze differences between male and female populations.

physical, psychological and social variables at baseline, and the dependent variable was death which occurred during the follow-up. The variables were analyzed with the Cox proportional hazard model by sex, and the obtained results were compared. Firstly, age of the subjects was adjusted, and each variable was subjected to univariate analysis. Secondly, after adjustment of age, all variables which showed statistical significances by the univariate analysis were used in the Cox hazard model for the multivariate analysis.

The multivariate analysis produces a probability of multicollinearity. So, when the coefficient of correlation between two variables exceeded 0.5, we adopted 1 variable only for the analysis. Then, we carried out discriminant analysis using variables which remained in the model after multivariate analysis. We considered a *P* value of 0.05 or less to be statistically significant for both the univariate and multivariate analyses. Statistical analysis was performed with SPSS/PC+ statistical software for Windows version 12.0 (SPSS Japan, Tokyo, Japan).

Results

Table 1 shows the number of deaths that occurred during the 3 year follow-up. The number of deaths was 79 in total (49 men, 30 women). The sex difference was statistically significant in mortality for the independent elderly. Figure 1 shows causes of death during the follow-up period. In both sexes, the highest cause was malignant neoplasm, followed by cardiac disease and respiratory tract disease. Especially in men, death by malignant neoplasm was more frequent than in women. Two men and one woman committed suicide during the 3 years.

Univariate analysis

Table 2 shows the univariate analysis of risk factors for death in the elderly during 3 years of follow-up using the Cox proportional hazard model. Age of the elderly was a significant risk factor of death ($P < 0.01$), as expected. In men, place of daily activities (homebound factors) ($P < 0.01$), subjective health (psychological and mental status factors) ($P < 0.01$), domestic role (QOL factors) ($P < 0.01$), tobacco (lifestyle factors) ($P < 0.05$) and restriction of going out due to incontinence (physical factors) ($P < 0.05$) were associated with death. In women, fewer variables were significantly correlated to death: only two of the TMIG Index of Competence subscales were correlated. When the analysis was based on the total population, subjective well-being also was significantly

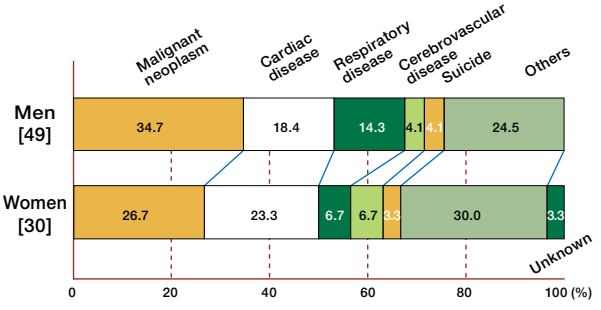

Fig. 1. Causes of death in the elderly men and women that occurred during the follow-up period of 3 years between 2001 and 2004.

Table 2. Univariate analysis of risk factors for death in the follow-up subjects during 3 years

Risk factor / Category	Men [529]			Women [755]		
	Dead	Alive	Dead versus alive	Dead	Alive	Dead versus alive
	Number (%)	Number (%)	(HR: 95% CI)	Number (%)	Number (%)	(HR: 95% CI)
Demographic variables						
Age (mean ± SD)	78.94 ± 5.89	75.75 ± 5.70	1.08: 1.04–1.13**	83.30 ± 7.82	76.84 ± 5.98	1.16: 1.10–1.22**
Homebound variables						
Place of daily activities						
Out	39 (79.6)	452 (94.2)	1.00	24 (80.0)	660 (91.0)	1.00
Home	10 (20.4)	28 (5.8)	3.34: 1.67–6.71**	6 (20.0)	65 (9.0)	1.49: 0.59–3.77
TMIG Index of Competence subscales						
Self-preparing of meals						
Can	33 (67.3)	409 (85.2)	1.00	24 (80.0)	671 (92.6)	1.00
Cannot	16 (32.7)	7 (14.8)	2.12: 1.14–3.94*	6 (20.0)	54 (7.4)	0.83: 0.30–2.28
Skill in handling banking						
Have	46 (93.9)	456 (95.0)	1.00	19 (63.3)	643 (88.7)	1.00
Have not	3 (6.1)	24 (5.0)	0.93: 0.29–3.02	11 (36.7)	82 (11.3)	2.45: 1.12–5.39*
Newspaper reading						
Do	46 (93.9)	461 (96.0)	1.00	20 (66.7)	638 (88.0)	1.00
Do not	3 (6.1)	19 (4.0)	1.25: 0.39–4.04	10 (33.3)	87 (12.0)	2.21: 1.01–4.83*
Lifestyle						
Tobacco						
No smoking	28 (57.1)	339 (70.6)	1.00	28 (93.3)	670 (92.4)	1.00
Smoke	21 (42.9)	141 (29.4)	2.09: 1.17–3.71*	2 (6.7)	55 (7.6)	0.76: 0.18–3.18
Psychological and mental status						
Subjective health						
Healthy	25 (51.0)	348 (72.5)	1.00	15 (50.0)	517 (71.3)	1.00
Not healthy	24 (49.0)	132 (27.5)	2.47: 1.41–4.32**	15 (50.0)	208 (28.7)	2.03: 0.99–4.16
Quality of life (QOL)						
Domestic role						
Some	17 (34.7)	283 (59.0)	1.00	20 (66.7)	610 (84.1)	1.00
None	32 (65.3)	197 (41.0)	2.33: 1.29–4.21**	10 (33.3)	115 (15.9)	1.17: 0.51–2.69
Physical status						
Going-out restriction due to incontinence						
Not limited	42 (85.7)	458 (95.4)	1.00	28 (93.3)	679 (93.7)	1.00
Limited	7 (14.3)	22 (4.6)	2.49: 1.11–5.61*	2 (6.7)	46 (6.3)	0.52: 0.12–2.23

[ ], population size; CI, confidence interval; HR, hazard ratio; TMIG, Tokyo Metropolitan Institute of Gerontology. HR analysis, based on the Cox proportional hazard model.
Age of the studied population, adjusted.
* $P < 0.05$.
** $P < 0.01$.

correlated with death (not listed in Table 2): hazard ratio; 1.74 and 95% confidence interval; 1.04–2.91.

Multivariate analysis

Table 3 shows the multivariate analysis of risk factors for death in the elderly followed up for 3 years using the Cox proportional hazard model. An independent risk factor for death common to both sexes was aging ($P < 0.01$). Men's significant risk factors were subjective health ($P < 0.01$), domestic role ($P < 0.01$) and tobacco ($P < 0.05$). Women's only risk factor was skill in handling banking. By using baseline information, the discriminant analysis predicted 67.0% of deaths in men as expectable from four risk factors of aging, subjective health, domestic role and tobacco. On

Table 3. Multivariate analysis of risk factors for death in the follow-up subjects during 3 years

Risk factor Category	Men [529] Dead versus alive (HR: 95% CI)	Women [755] Dead versus alive (HR: 95% CI)
Aging (per year)	1.09: 1.04–1.14**	1.13: 1.07–1.20**
Subjective health		
Healthy	1.00	
Not healthy	2.45: 1.40–4.30**	
Domestic role		
Have	1.00	
Have not	2.21: 1.22–4.01**	
Tobacco		
No smoking	1.00	
Smoke	1.96: 1.10–3.48*	
Skill in handling banking		
Have		1.00
Have not		2.45: 1.12–5.39*
Discriminant analysis	67.0%	74.2%

[ ], population size; CI, confidence interval; HR, hazard ratio.
HR analysis, based on the stepwise Cox proportional hazard model.
Age of the studied population, adjusted.
* $P < 0.05$.
** $P < 0.01$.

the other hand, in women, the analysis predicted 74.2% of deaths as expected from two risk factors of aging and skill in handling banking. Men's sensitivity, specificity and positive predictive value were 19.8%, 95.3% and 69.6%, respectively. Women's sensitivity, specificity and positive predictive value were 7.3%, 97.2% and 46.7%, respectively.

Discussion

In studying physical and psychosocial risk factors for death in the Japanese countryside, we observed that men's mortality during the follow-up was higher than women's and slightly higher than that of younger, 65- to 74-year-old men. Most developed countries have a sex difference in life expectancy and death, where women live 5 to 9 years longer than men (Kinsella and Taeuber, 1993; Mongella, 1995). In Sweden, von Strauss et al. (2003) performed a survey for the elderly, in whom the age was slightly different from ours: 77- to 84-year-old independently living men had a higher risk of death than age-matched women.

We compared the proportion of causes of death between Kishimoto Town and the whole country (Japan Health and Welfare Statistics Association, 2004). Mortality by cerebrovascular disease was lower and mortality by cardiac or respiratory disease was higher in Kishimoto Town. This fact seems to result from our confinement of elderly subjects exceeding 65 years. The suicides observed in Kishimoto Town were in accordance with the current national trend (Japan Health and Welfare Statistics Association, 2004).

The univariate and multivariate analyses of risk factors for death showed aging, subjective health, domestic role and tobacco for men. Aging was the biologically natural sequence. Subjective health was defined as "the individual's perception and evaluation of his or her overall health" (Liang, 1986). Many researchers reported it as a predictor of death in the elderly (Mendes de Leon et al., 1996; Mossey and Shapiro, 1982; Tsuji et al., 1994; Menec et al., 1999; Idler and Benyamini, 1997; Helmer et al., 1999; Kushiro et al., 2003). These surveys included the dependent elderly to subjects; however, we excluded the elderly who had damaged ADL or were living dependently. To our knowledge, our study is the first to prove the risk of death exactly in functionally independent elderly persons. Smoking is a life habit well known as a risk factor for death (Ishii et al., 2000; Simons et al., 2005). The smoking rate is high in men, and tobacco exerts serious effects on their health. No domestic role was a significant risk factor for death in elderly men. In our univariate analysis, their skill in preparing meals for themselves was a risk only for men. Domestic work in the Japanese family like housekeeping are handled by women, while men are much more involved in social roles. When Japanese men retire from their job at around 60 years of age, they rapidly lose their role in society and their

conscience to work falls. Men should have some domestic role until or after retirement. Domestic work keeps their ADL or family relations in good condition. We studied family structure also as an independent variable, but both univariate and multivariate analyses showed no statistical significance.

In the elderly women, skill in handling banking was the only variable showing a significant difference. This lack of significant variables could be attributed to the short follow-up period and smaller number of deaths, especially in women. Among the women who had died later on, 50.0% and 83.3% gave low answers to subjective health (hazard ratio and 95% confidence interval; 2.03 and 0.99–4.16) and pain in the lower half of the body (2.52 and 0.96–6.61) (*P*, not significant in both). When the elderly cannot handle their own banking, they might be inclined to be homebound, they might suffer from dementia, or their competence in instrumental self-maintenance might be poor in handling banking. In Japan, the public pension is automatically transferred to a person's bank account. According to the 2004 National Life Basics Investigation in Japan, the public or national pension income was the only income in 64.2% of the whole of senior citizen households (Ministry of Health, Labor and Welfare of Japan Cabinet Secretary Statistics and Informatics Department Social Statistics Division National Life Basics Investigation Section, 2005). Additionally, this variable might mean that they had little money they could use freely, suggesting their financial sparsity. Individual income and health are correlated (Backlund et al., 1996; Veenstra, 2003). Effects of income inequality on women's subjective health are known (no significant difference) (Blakely et al., 2002). Living with a low income is a risk factor for death, and the relationship is marked in very aged women (Veenstra, 2003). We did not ask our subjects to write the family income, as we were not studying the effects of this predictor of death.

The present multivariate analysis showed no statistical significances in traditional risk factors for death (Gilbert et al., 1992) in both sexes. We observed significant differences in place of daily activities and restriction in going out due to incontinence for men by univariate analysis. So, the tendency to be homebound seemed to be a risk factor for death. Men's death received more significant effects from psychosocial factors, than from physical factors. According to Pfeiffer (1970) who studied factors for longevity, the duration of a human life is regulated compositely by biological, psychological and social factors.

In the present study, men who were aged, who evaluated badly with subjective health, who had no domestic role or who smoked at baseline survey showed a 69.6% probability for death within the following 3 years (the positive predictive value). The value was 46.7% in women who were aged or who had no skill in handling banking. Particularly, the positive predictive value was high in men who smoked, bad subjective health or no domestic role. The impact of these findings is very significant in the field of public health. However, sensitivity was very low in both sexes in this survey. To increase the validity of screening it is necessary to prolong the follow-up period. These risk factors for death can be lowered by the efforts of the elderly themselves, their family or supporting persons. Men's early death could be prevented when good public health measures for men are taken seriously. The tobacco prohibition movement started by the Ministry of Health, Labour and Welfare of Japan in March 2000 has continued up to the present time. If some factors are improved, the occurrence of death could at least be postponed. For example, improving psychosocial risk factors may directly work for prevention of suicide. As observed in younger generations, quitting tobacco should lead to the prevention of death from tobacco-derived neoplasms and circulatory diseases.

The potential weak point of our survey was the small number of deaths especially in women because of the short period of follow-up. This was the reason for our difficulties in finding statistically significant risk factors. We used the

self-administered method to all items including physical factors and other objectively measurable indices. This might cause some bias in the results. Today, individual-based, relative and subjective assessment draws much attention (Oda, 2003). The answer rate at baseline was as high as 94.9%, and a few subjects moved out of the town during the follow-up. So, the effects of the above weak points were minimal. The day of death recorded by the nation-wide local resident registration system was accurate, and we could smoothly calculate the observation period for each subject. In addition, the official death certificate form is quite reliable in the aspect of information of mortal disease. In the future in this series of studies, we will set a longer follow-up period for more detailed analysis of risk factors, to make predictors of death clearer by classifying age and causes of death. Finally, by investigating how the elderly become disordered or dependent, we should clarify factors for active-life expectancy.

The present prospective cohort study followed up for 3 years elucidated the predictors of death in functionally independent elderly persons living in Japan. Psychosocial factors exerted direct effects on death, irrespective of the effects of physical factors. This tendency was particularly marked in men. To lower mortality in independent elderly men and women in a community, planning better public health programs for improvement of their QOL is eagerly waited.

Acknowledgments: We are grateful to Professor Yoichi Kurozawa of the Division of Health Administration and Promotion, Department of Social Medicine, and Professor Soji Fukumoto of the Division of Medical Zoology, Department of Microbiology and Immunology, School of Medicine, Tottori University Faculty of Medicine, for their critical reading of the manuscript. We also thank Ms. Yoko Ishikawa of the Division of Environmental and Preventive Medicine, Department of Social Medicine, School of Medicine, Tottori University Faculty of Medicine for her cooperation in calculating the collected information.

This study was supported in part by a Grant-in-Aid for Scientific Research B (2), [An elderly cohort study on predictors for prevention of dependent living toward business valuation], from the Ministry of Education, Culture, Sports, Science and Technology of Japan (YO: 15390200).

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Received October 24, 2006; accepted November 17, 2006

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