

Effects on Mortality of Getting the Basic Health Examination Under the Health Services for the Elderly Act and Modification of the Effects by Health Status Among Elderly Persons in a Rural Community

Kiwa Maeda ¹, Nobufumi Yasuda ¹, Hiroshi Ohara ¹, and Yoshio Mino ²

This longitudinal study examines the effect on mortality of regular use of the basic health examination under the Health Services for the Elderly Act and heterogeneity of the effect according to levels of physical and mental health status among community dwelling elderly persons. Of persons aged 65 and older who lived in Otsuki town, Kochi prefecture, and completed a questionnaire survey about health in February 1991, 1,470 survivors on the anniversary of the baseline survey were followed by the end of March 1996. Regularity of getting the examination was determined by the history of use of the examination in 1990 and 1991. Mortality reduction associated with annual use of the examination was observed in both the 65-74 and the 75 and older age groups and the benefit got smaller with advancing in age. In the 75 and older age group, the benefit from annual use of the examination was restricted to persons having no impairment in physical activities of daily living and those having favorable mental health. Biennial use of the examination was associated with the same amount of mortality reduction as annual use among persons having chronic conditions under treatment in the 65-74 age group. Regular use of the basic health examination at old ages is effective and the effectiveness varies by age range and level of functional health status.

J Epidemiol, 2000 ; 10 : 22-28

effect modifiers, health services for the aged, health status, mortality

The Ministry of Health and Welfare of Japan implemented the Health Services for the Elderly Act in 1983, based on the expectation that provision of preventive health services since middle ages contributes to well-being at old ages. Preventive health services under the Act include six items which local municipalities provide for residents aged 40 and older; 1) general health examinations called basic health examinations with special examinations when indicated and cancer screening for stomach, uterus, breast, lung, and colon, 2) Issue of a health notebook, 3) Health education, 4) Individual health counseling, 5) Rehabilitation programs, and 6) Home visit guidance ^{1,2}. The basic health examination, which aims at prevention of hypertension, cerebrovascular disease, heart disease, diabetes mellitus, anemia, liver disease, and renal disease, is widely performed. The number of persons who got the examination was 9.91 million in 1995, accounting for 37% of eligible persons ³.

Facing the increase in the burden of care for elderly persons, it is an urgent necessity to evaluate the effectiveness of preventive health services under the Act. Randomized controlled trials are the most persuasive form to evaluate the effectiveness. Unfortunately, conducting such studies on the services under the Act are impossible because they are extensively performed. With regard to the basic health examination, other study designs have been chosen to evaluate its effectiveness. Correlational studies at municipality level reported that there was an inverse correlation between the proportion of residents who used the examination and the inpatient and outpatient care cost by elderly persons ^{1,2}. A design of analytic studies, which is superior to correlational studies in evaluating the causality of the association, has also been used. Nakanishi et al conducted longitudinal studies on effects of use of various checkups on mortality among residents aged 65 and older living in an urban

Received March 8, 1999 ; accepted May 19, 1999.

¹Department of Public Health, Kochi Medical School.

²Department of Hygiene and Preventive Medicine, Okayama University Medical School.

Address for correspondence : Kiwa Maeda Department of Public Health, Kochi Medical School Kohasu, Okoh-cho, Nankoku-shi, Kochi 783-8505 Japan.

community^{4,5}). They reported that regular use of checkups since middle ages (mostly at workplace) was effective in reducing all cause deaths as well as deaths due to major causes. However, getting health examinations under the Act did not influence mortality after adjustment for potential confounders. Because their study defined the pattern of getting health examinations by combining use of the basic health examinations and use of cancer screening since middle ages, it did not clarify the sole effect on mortality of getting the basic health examination at old ages.

Persons who get health examinations are known to be biased in terms of health status⁶. In analytic studies on the effectiveness of health examinations, health status at baseline is usually considered a potential confounder. However, if the influence of health status on the relation between use of health examinations and mortality is heterogeneous, that is, health status is an effect measure modifier, it is inappropriate to treat health status as a confounder⁷. One way to cope with the issue is to perform analysis stratified by health status at baseline. Such analysis is useful because it reveals who are most likely to benefit from health examinations.

This longitudinal study aims to evaluate the effectiveness of regular use of the basic health examination under the Health Services for the Elderly Act at old ages in terms of mortality and to clarify characteristics of persons who benefit from the examination. As potential effect measure modifiers, the present study focuses on physical and mental health status.

MATERIALS AND METHODS

Study subjects

The study community, Otsuki town, is located 160 km southwest of Kochi city and is engaged in agriculture and fishing. The population was about 8,000 and the proportion of persons aged 65 years and older was 23 % in 1990. A questionnaire survey about health status and lifestyle characteristics was conducted for all noninstitutionalized residents aged 65 years and older in February 1991. Of 1,659 noninstitutionalized persons, 1,514 (91%) responded to the questionnaire survey. Reasons for non-response included absence during the survey period (N=39) and refusal (N=106). After excluding four persons with unknown birth dates, 37 persons who died within one year after the baseline survey and 3 persons who moved out during the year, 1,470 persons were used in the present analysis. As described below, the present analysis classified the study subjects according to whether getting the basic health examinations in 1990 and 1991. Because the examination is scheduled from April to December of each year in the study community, persons who died within one year after the baseline survey included persons who had no opportunity to get the examination in 1991. In order to ensure that all study subjects had an opportunity to get the basic health examination

in both 1990 and 1991, persons who died or moved out within one year after the baseline survey were excluded.

Because it is recognized that the young-old (65-74 years) and old-old (75 and older years) differ in important ways in terms of their health status, life style characteristics, and their impact on health outcomes and mortality^{8,9}, the subjects were stratified by age at baseline; 901 persons aged 65-74 years [mean(standard deviation) of age, 69.0(2.9)] and 569 persons aged 75 and older [mean(standard deviation) of age, 80.7(4.9); the maximum of age,100]. There was no difference in reasons for non-response between the two age groups.

Study variables

Regularity of use of the basic health examination of individual subjects was determined by the pattern of getting the examination in 1990 and 1991. Annual lists of residents who got the basic health examinations held in the two years were provided by the local municipality. The subjects were classified into three groups; those who got the examination in both 1990 and 1991(annual, N=474), those who got the examination in either year(biennial, N=439), and those who did not get the examination for two years(neither, N=557).

The questionnaire survey in 1991 measured health status and lifestyle characteristics. Physical health status was assessed with perceived health, activities of daily living (ADL) impairment, and chronic conditions under treatment. Perceived health was measured on a five point scale; excellent, good, fair, poor, or bad. ADL impairment was evaluated by whether needing help in the six items; walking, bathing, going to toilet, dressing, grooming and eating. Persons who needed help in at least one ADL item were regarded as impaired. The subjects were asked whether they received treatment for the following chronic conditions which were aimed at in the basic health examination; hypertension, heart disease, cerebrovascular disease, hypercholesterolemia, and diabetes mellitus. As a measure of mental health status, the Japanese version of the 30 item General Health Questionnaire (GHQ-30)^{10,11} was used. The GHQ scoring method (range: 0-30) was used and persons scoring 8 and higher were considered having impaired mental health status. Since there is no report which assessed the cut point of GHQ score among elderly persons, the authors chose that used in a previous study for pregnant women¹². The proportion of persons scoring 8 and higher among those who completed GHQ-30 was 24% and 35%, respectively, in the 65-74 age group and in the 75 and older age group.

Follow-up status

During the follow-up period from February 1992 to March 31,1996, 19 persons moved out and 241 died. Underlying cause of death was ascertained via the death certificate and was coded according to the International Classification of Diseases, Ninth Revision (ICD-9). A total of 91 persons died of circula-

tory system diseases including cardiovascular disease (ICD-9 codes; 393-398, 410-429, 440-459), cerebrovascular disease (ICD-9 codes; 430-438), and hypertension (ICD-9 codes; 401-405). The number of deaths due to malignant neoplasms (ICD-9 codes; 140-208) was 66.

Statistical analysis

A Mantel-extension test was used to examine a trend in the association between each health status and the regularity of getting the basic health examination.

A Cox proportional hazards model was fitted to examine the influence on mortality of the regularity of getting the basic health examination. The proportional hazards assumption for the regularity of the examination was checked by a model containing an interaction between the variable and time¹³⁾, and the interaction was not significant in either age group at the probability level of 0.20. Since the interaction between gender and regularity of getting the examination was not significant in either age group ($p>0.15$), gender was treated as a potential confounder. In analysis for cause specific mortality, separate models were fitted for each cause of deaths and persons who had died of other causes were treated as censored at the time of death¹³⁾.

Modifying effects of health status on the association between use of the examination and mortality were examined by fitting a proportional hazards model in individual strata of each dichotomized health status variables.

RESULTS

Table 1 shows distribution of each health status variable according to the regularity of getting the basic health examina-

tion. The proportion of persons with no ADL impairment decreased significantly from annual to biennial to neither examinees in both age groups. On the other hand, the proportion of persons with no chronic conditions under treatment was higher in neither examinees than in annual and biennial examinees in the 65-74 age group.

Table 2 shows associations between health status at baseline and mortality after adjustment for age and gender. Except for chronic conditions under treatment, favorable health status was associated with decreased mortality in both age groups.

Table 3 shows age and gender adjusted hazard ratios of all cause and cause specific mortality for annual or biennial examinees compared with neither examinees. For all cause mortality, annual use of the examination was associated with decreased mortality in both age groups and the biennial use tended to be related to mortality reduction in the 65-74 age group. The benefit associated with getting the examination decreased with advancing in age. For major cause specific mortality, the benefit associated with getting the examination annually tended to be observed for both deaths due to circulatory system disease and deaths due to all non-circulatory system diseases. The benefit associated with annual use was statistically significant in the 65-74 age group. With regard to the effect on deaths due to malignant neoplasms, hazard ratios for annual and biennial use suggest a protective influence of the basic health examination in the 65-74 age group, although they were not statistically significant.

In order to examine whether the association between getting the basic health examination and subsequent mortality differs by level of health status at baseline, analysis was stratified by each health status variable. Because there was no essential difference in hazard ratios for use of the examination between a

Table 1. Distribution of health status variables according to regularity of getting the basic health examination by age group (%).

		65-74 age group						≥75 age group					
		Annual(N=328)		Biennial(N=266)		Neither(N=307)		Annual(N=146)		Biennial(N=173)		Neither(N=250)	
		Including unknown subjects	Excluding unknown subjects										
Perceived health	Excellent, Good, Fair	87.5	90.6	81.2	84.4	82.1	86.3	84.9	88.5	80.3	81.3	79.6	82.9
	Poor, Bad	9.1	9.4	15.0	15.6	13.0	13.7	11.0	11.5	18.5	18.7	16.4	17.1
	Unknown	3.4		3.8		4.9		4.1		1.2		4.0	
ADL impairment	Not impaired	90.9	98.7	87.2	94.0	82.4	92.0 **	86.3	89.3	80.3	86.3	73.2	78.2 **
	Impaired	1.2	1.3	5.6	6.0	7.2	8.0	10.3	10.7	12.7	13.7	20.4	21.8
	Unknown	7.9		7.1		10.4		3.4		6.9		6.4	
Conditions under treatment	Not having	57.9	57.9	59.4	59.4	69.4	69.4 **	57.5	57.5	43.9	43.9	56.4	56.4
	Having	42.1	42.1	40.6	40.6	30.6	30.6	42.5	42.5	56.1	56.1	43.6	43.6
GHQ score	≤7	70.1	77.2	71.4	76.6	65.8	73.7	66.4	70.3	60.1	67.1	53.2	61.3
	≥8	20.7	22.8	21.8	23.4	23.5	26.3	28.1	29.7	29.5	32.9	33.6	38.7
	Unknown	9.1		6.8		10.7		5.5		10.4		13.2	

** : Difference across regularity of getting the examination when excluding unknown subjects by Mantel-extension test <0.01 .

Table 2. Associations between health status variables and mortality by age group.

		65-74 age group					≥75 age group								
		No. followed	Person-years	No. who died	Crude mortality rate × 100 person-years	Hazard ratio adjusted for age and gender	No. followed	Person-years	No. who died	Crude mortality rate × 100 person-years	Hazard ratio adjusted for age and gender				
							95% CI †							95% CI †	
Perceived health	Excellent, Good, Fair	755	4018.5	51	1.3	0.50	0.28-0.88*	462	2261.0	102	4.5	0.61	0.40-0.93*		
	Poor, Bad	110	566.0	16	2.8	1‡		89	401.5	27	6.7	1‡			
ADL impairment	Not impaired	783	4174.5	52	1.2	0.21	0.11-0.40**	448	2222.0	86	3.9	0.57	0.38-0.85**		
	Impaired	41	188.5	12	6.4	1‡		88	359.0	40	11.1	1‡			
Conditions under treatment	Not having	561	2968.5	49	1.7	1.39	0.83-2.33	301	1462.5	69	4.7	0.99	0.71-1.39		
	Having	340	1808.0	21	1.2	1‡		268	1285.0	65	5.1	1‡			
GHQ score	≤7	622	3334.0	33	1.0	0.41	0.24-0.69**	334	1650.0	66	4.0	0.69	0.48-0.99*		
	≥8	198	1025.0	23	2.2	1‡		176	812.0	54	6.7	1‡			

*: p < 0.05, **: p < 0.01.

†: Confidence interval.

‡: Reference category.

Table 3. All cause and cause specific mortality according to regularity of getting the basic health examination by age group.

		65-74 age group					≥75 age group								
		No. followed	Person-years	No. who died	Crude mortality rate × 100 person-years	Hazard ratio adjusted for age and gender	No. followed	Person-years	No. who died	Crude mortality rate × 100 person-years	Hazard ratio adjusted for age and gender				
							95% CI †							95% CI †	
All causes	annual	328	1774.0	12	0.7	0.31	0.16-0.59**	146	752.0	22	2.9	0.58	0.36-0.94*		
	biennial	266	1412.0	19	1.3	0.61	0.35-1.05	173	853.5	39	4.6	0.87	0.59-1.29		
	neither	307	1590.5	39	2.5	1‡		250	1142.0	73	6.4	1‡			
Circulatory system disease	annual	328	1774.0	3	0.2	0.21	0.06-0.73*	146	752.0	7	0.9	0.49	0.21-1.13		
	biennial	266	1412.0	4	0.3	0.35	0.12-1.07	173	853.5	21	2.5	1.25	0.70-2.23		
	neither	307	1590.5	14	0.9	1‡		250	1142.0	27	2.4	1‡			
All non-circulatory system diseases (including malignant neoplasms)	annual	328	1774.0	9	0.5	0.36	0.17-0.78**	146	752.0	15	2.0	0.63	0.35-1.15		
	biennial	266	1412.0	15	1.1	0.75	0.40-1.43	173	853.5	18	2.1	0.64	0.37-1.11		
	neither	307	1590.5	25	1.6	1‡		250	1142.0	46	4.0	1‡			
Malignant neoplasms	annual	328	1774.0	8	0.5	0.64	0.26-1.55	146	752.0	9	1.2	0.96	0.41-2.25		
	biennial	266	1412.0	8	0.6	0.78	0.32-1.90	173	853.5	7	0.8	0.68	0.27-1.69		
	neither	307	1590.5	13	0.8	1‡		250	1142.0	14	1.2	1‡			

*: p < 0.05, **: p < 0.01.

†: Confidence interval.

‡: Reference category.

model which included the remaining three health status variables into covariates and a model which did not, results from a model adjusted for age and gender are presented. Table 4 shows associations between the regularity of getting the examination and all cause mortality in each stratum of individual health status variables. The association was not evaluated for persons with ADL impairment in the 65-74 age group because of the small sample size.

In the 65-74 age group, a large amount of benefit from annual use of the examination and a reduced amount of benefit from biennial use were likely to be observed in both favorable

and unfavorable strata of perceived health and GHQ-30 and in the stratum of no ADL impairment. The benefit was significant in the favorable stratum of each health status variable. Interestingly, among persons having chronic conditions under treatment, both annual and biennial use was associated with the same amount of mortality reduction. On the other hand, in the 75 and older age group, the benefit associated with annual use of the examination was restricted to persons having no ADL impairment and those scoring 7 and lower in GHQ-30. Among persons who had impairment in ADL and those scoring 8 and higher in GHQ-30, use of the examination had no

Table 4. All cause mortality according to regularity of getting the basic health examination by age group when stratified by various health status variables.

			65-74 age group					≥75 age group						
			No. followed	Person-years	No. who died	Crude mortality rate × 100 person-years	Hazard ratio adjusted for age and gender	95% CI †	No. followed	Person-years	No. who died	Crude mortality rate × 100 person-years	Hazard ratio adjusted for age and gender	95% CI †
Perceived health	Excellent, Good, Fair	annual	287	1555.5	9	0.6	0.30	0.14-0.63**	124	639.0	19	3.0	0.62	0.36-1.05
		biennial	216	1149.0	14	1.2	0.63	0.33-1.19	139	696.5	28	4.0	0.87	0.55-1.39
		neither	252	1314.0	28	2.1	1‡		199	925.5	55	5.9	1‡	
	Poor, Bad	annual	30	162.0	1	0.6	0.13	0.02-1.06	16	80.0	3	3.8	0.91	0.24-3.46
		biennial	40	210.0	4	1.9	0.40	0.13-1.30	32	147.0	10	6.8	0.89	0.39-2.03
		neither	40	194.0	11	5.7	1‡		41	174.5	14	8.0	1‡	
ADL impairment	Not impaired	annual	298	1616.0	9	0.6	0.28	0.13-0.59**	126	660.0	15	2.3	0.49	0.27-0.88*
		biennial	232	1241.0	13	1.0	0.51	0.27-0.99*	139	699.5	26	3.7	0.73	0.45-1.19
		neither	253	1317.5	30	2.3	1‡		183	862.5	45	5.2	1‡	
	Impaired	annual	4	15.0	2	13.3	∞¶		15	64.5	7	10.9	1.07	0.45-2.51
		biennial	15	67.5	5	7.4	∞¶		22	94.0	10	10.6	1.76	0.77-4.01
		neither	22	106.0	5	4.7	∞¶		51	200.5	23	11.5	1‡	
Conditions under treatment	Not having	annual	190	1033.0	6	0.6	0.29	0.12-0.69**	84	437.0	11	2.5	0.53	0.27-1.05
		biennial	158	826.0	16	1.9	0.91	0.49-1.69	76	364.0	20	5.5	1.06	0.62-1.83
		neither	213	1109.5	27	2.4	1‡		141	661.5	38	5.7	1‡	
	Having	annual	138	741.0	6	0.8	0.33	0.12-0.89*	62	315.0	11	3.5	0.65	0.32-1.29
		biennial	108	586.0	3	0.5	0.21	0.06-0.75*	97	489.5	19	3.9	0.72	0.41-1.28
		neither	94	481.0	12	2.5	1‡		109	480.5	35	7.3	1‡	
GHQ score	≤7	annual	230	1251.0	5	0.4	0.22	0.08-0.59**	97	512.5	9	1.8	0.31	0.15-0.66**
		biennial	190	1024.0	7	0.7	0.39	0.16-0.92*	104	527.0	20	3.8	0.67	0.39-1.16
		neither	202	1059.0	21	2.0	1‡		133	610.5	37	6.1	1‡	
	≥8	annual	68	365.0	4	1.1	0.34	0.11-1.05	41	198.5	12	6.0	1.16	0.58-2.31
		biennial	58	301.0	6	2.0	0.54	0.20-1.41	51	236.5	15	6.3	1.14	0.60-2.16
		neither	72	359.0	13	3.6	1‡		84	377.0	27	7.2	1‡	

*: $p < 0.05$, **: $p < 0.01$.

†: Confidence interval.

‡: Reference category.

¶: No computation of hazard ratio.

protective influence on mortality.

DISCUSSION

It has not been clarified whether getting the basic health examination under the Health Services for the Elderly Act after reaching advanced ages is effective or not. The authors evaluated an effect of regular use of the examination on subsequent mortality by defining the regularity based on actual use of the examination for two consecutive years. The present analysis reveals that annual use of the examination at old ages protects premature deaths of elderly persons. Although the benefit gets smaller in advancing in age, it is still significant in the 75 and older age group. The benefit is unlikely to be restricted to specific causes of death, although the effect on deaths due to malignant neoplasms may be small.

In the study population, health status is not a confounder but

an effect measure modifier of the association between regular use of the basic health examination and mortality in the 75 and older age group. In this age group, the effect of regular use of the examination on mortality was observed when annual examinees were not impaired in ADL or in mental health status. It seems that annual use of the basic health examination may be beneficial to persons who maintain high levels of functional health in this age group. Persons with impairment in functional health may have been too ill and impaired to benefit from the examination and accompanied health services¹⁴⁾.

On the other hand, in the 65-74 age group, the principle pattern of the relation is that both annual and biennial use of the examination was associated with reduced mortality regardless of levels of health status, and that the benefit from biennial use was smaller than that from annual use. The exception was observed among persons who got medical treatment for chronic conditions which the basic health examination is targeted on.

Among such persons, biennial use of the examination was associated with the same extent of reduction of mortality risk as annual use. The basic health examination is usually promoted to persons who do not receive treatment for chronic conditions in medical facilities. The present study indicates that the criteria to define the target population eligible for the basic health examination should be altered by age group. It seems to be inappropriate to remove residents at 65-74 ages who have chronic conditions under treatment from the target. In the 75 and older age group, it is reasonable to exclude persons who are impaired physically and mentally from the target.

In order to explain the benefit from regular use of the basic health examination, attention should be paid to health services following the health examination. In western countries, a strategy of comprehensive geriatric assessment was developed as a preventive health service for elderly persons. The comprehensive geriatric assessment determines an elderly person's medical, psychological, functional, and environmental resources and problems, linked with an overall plan for treatment and follow-up^{15,16}. Two characteristics have been reported to be attributable to the effectiveness of the assessment: targeting the assessment on elderly persons most likely to benefit, and the link of the assessment with active follow-up. The basic health examination is a preventive health service which should be incorporated into various follow-up services. Usually, health counseling and home visit guidance at individual level and health education at group level follow the basic health examination. Such health services may play important roles in performing effective health examinations. Furthermore, special situations of the study community may contribute to the effectiveness of the examination. The local municipality of the study community runs the only polyclinic in the study area. The staff of the facility not only provide medical care services for the residents but also participate in the basic health examination as examiners. Therefore, the linkage between assessment in the basic health examination and subsequent provision of services seems to be streamlined. The public health nurses at the local municipality and the staff of the medical facility cooperate to mobilize health and medical care services for elderly persons who need them¹⁷.

Several limitations of the present study are as follows. Firstly, health status measures chosen in the present analysis were all self-reported ones. Objective measures which were obtained from the basic health examination, for example blood pressure, were not used. The authors performed analysis for 764 persons who got the examination in 1990 in order to assess influences of such objective health measures on mortality difference between annual and biennial users. However, meaningful findings were not obtained because of the reduced sample size and relatively low mortality of persons who got the examination. Secondly, the benefit from use of the examination at old ages may be attributable to getting regular health

examinations since middle ages. In order to assess this possibility, the history of use of health examinations at middle ages should have been collected. Unfortunately, such records were unavailable to the present study. Thirdly, since the present study was conducted in a rural community with special situations, caution must be exercised to generalize the findings to other settings.

In spite of the limitations, the present findings shed light on the beneficial influence of regular use of the basic health examination at advanced ages. More attention must be paid to variability of the effectiveness according to age groups and levels of functional health status. In future studies, the effectiveness should be evaluated on other health outcomes such as physical and cognitive function and medical care use.

ACKNOWLEDGMENTS

The authors thank Dr. Kazuya Yoshii, Kayoko Hamada and staff of health and welfare section of Otsuki town office for their support of the present study.

Support of this study was provided by the Ministry of Education, Science and Culture grant no.02670241.

REFERENCES

1. Nakanishi N, Tatara K, Fujiwara H. Do preventive health services reduce eventual demand for medical care? *Soc Sci Med* 1996;43:999-1005.
2. Tatara K, Sinsho F, Suzuki M, et al. Relation between use of health check ups starting in middle age and demand for inpatient care by elderly people in Japan. *BMJ* 1991;302:615-8.
3. Health and Welfare Statistics Association. *Kokumin eisei no doko. Kosei no shihyo* 1996; 44 (special publication) (in Japanese).
4. Nakanishi N, Tatara K, Takatorige T, Murakami S, Shinsho F. Effects of preventive health services on survival of the elderly in Osaka, Japan. *J Epidemiol Community Health* 1997;51:199-204.
5. Nakanishi N, Tatara K, Nishina M, et al. Relationships of disability, health management and psychosocial conditions to cause-specific mortality among a community-residing elderly people. *J Epidemiol* 1998;8:195-202.
6. Theobald H, Bygren LO, Carstensen J, Hauffman M, Engfeldt P. Effects of an assessment of needs for medical and social services on long-term mortality: a randomized controlled study. *Int J Epidemiol* 1998;27:194-8.
7. Kleinbaum DG, Kupper LL, Muller KE. Confounding and interaction in regression. In: Kleinbaum DG, Kupper LL, Muller KE (eds). *Applied regression analysis and other multivariable methods*, 2nd ed. Duxbury Press, California, 1988: 163-180.

8. Taeuber CM, Rosenwaike I. A demographic portrait of America's oldest old. In: Suzman RM, Willis DP, Maton KG, eds. *The oldest old*. Oxford University Press, New York, 1992:17-49.
9. Yasuda N, Zimmerman SI, Hawkes W, et al. Relations of social network characteristics to 5-year mortality among young-old versus old-old white women in an urban community. *Am J Epidemiol* 1997; 145: 516-23.
10. Goldberg DP. *The detection of psychiatric illness by questionnaire*. Oxford University Press, London, 1972
11. Nakagawa Y, Daibo I. Japanese version of the general health questionnaire. Nihon Bunka Kagakusha, Tokyo, 1985 (In Japanese).
12. Kitamura T, Sugawara M, Aoki M, et al. Validity of the Japanese version of the GHQ among antenatal clinic attendants. *Psychol Med* 1989;19:507-11.
13. Allison PD. *Survival analysis using the SAS system: a practical guide*. SAS Institute Inc., Cary, NC, 1995.
14. Applegate WB, Miller ST, Graney J, et al. A randomized, controlled trial of a geriatric assessment unit in a community rehabilitation hospital. *New Engl J Med* 1990;322:1572-8.
15. National Institutes of Health. National Institutes of Health Consensus Development Conference Statement: Geriatric Assessment Methods for Clinical Decision-Making. *J Am Geriatr Soc* 36;1988:342-47.
16. Stuck AE, Siu AL, Wieland GD, Adams J, Rubenstein LZ. Comprehensive geriatric assessment: a meta-analysis of controlled trials. *Lancet* 342;1993:1032-1036.
17. Hamada K. What services are provided by local governments in the future? *Koushueisei*. 1997;61:17-21 (in Japanese).