ORIGINAL SCIENTIFIC PAPER

QUANTITATIVE RESEARCH

The association between living alone and frailty in a rural Japanese population: the Nagasaki Islands study

Hirotomo Yamanashi MD;[1,4] **Yuji Shimizu** MD, PhD;[2] **Mark Nelson** MD, PhD;[3] **Jun Koyamatsu** MD;[4] **Mako Nagayoshi** PhD;[2] **Koichiro Kadota** MD, PhD;[2] **Mami Tamai** MD, PhD;[5] **Koya Ariyoshi** MD, PhD;[1] **Takahiro Maeda** MD, PhD[2,4]

[1] Department of Clinical Medicine, Institute of Tropical Medicine, Nagasaki University, Sakamoto, Nagasaki, Japan

[2] Department of Community Medicine, Nagasaki University Graduate School of Biomedical Science, Sakamoto, Nagasaki

[3] Department of General Practice, University of Tasmania, Hobart, Tasmania, Australia

[4] Department of Island and Community Medicine, Nagasaki University Graduate School of Biomedical Science, Goto, Nagasaki

[5] Department of Immunology and Rheumatology, Nagasaki University Graduate School of Biomedical Science, Sakamoto, Nagasaki

ABSTRACT

INTRODUCTION: Demographic changes in Japan have resulted in an increased number of elderly living alone.

AIM: The aim of this study was to identify if there is an association between frailty and living alone.

METHODS: We conducted a cross-sectional study of 1602 Japanese men and women living in isolated islands. Information obtained included height, body weight, handgrip strength, and family structure; antihypertensive, hypoglycaemic, and lipid-lowering medication use; history of stroke or ischaemic heart disease, smoking history, alcohol intake, joint pain or swelling. Relevant laboratory test results were obtained from recent health check-ups. The Frailty Index for Japanese elderly, a 15-item self-report questionnaire was completed by participants and the Kessler Psychological Distress Scale (K6) was administered.

RESULTS: After individuals aged below 60 years old or those with missing data were excluded, data from 1224 participants were analysed. Living alone (single household family structure) was significantly associated with frailty in men (odds ratio [OR] 3.85; 95% confidence interval [CI] 1.94–7.65), but not in women (OR 1.08; 95% CI 0.72–1.63). This association in men remained statistically significant after adjustment for known risk factors for frailty.

DISCUSSION: In the elderly population in rural Nagasaki, men living alone have a high risk of frailty. Screening and intervention to prevent frailty in this population is urgently needed.

KEYWORDS: Frail elderly; independent living; Japan; living arrangement; risk factors; rural population

Introduction

Expenditure on medical and long-term care for the elderly population has risen exponentially in Japan, which has the world's most rapidly ageing society.[1,2] Frail, community-dwelling, elderly people are more likely to suffer falls, have worsening chronic morbidity, and reduced activities of daily living. The risk of hospitalisation and death is high.[3] The percentage of elderly in the Japanese population is increasing much more rapidly in remote areas, such as isolated islands, than in urban areas.[4] Demographic changes in Japan have also led to more elderly people living alone.[5] Living alone may be associated with frailty among the elderly, but previous studies have failed to examine the relationship between family structure and frailty.[3,6] One study reported a significantly higher proportion of frail elderly lived alone compared to those who were not frail,[3] although it did not investigate other possible confounders. Another study showed contradictory results and found an association with pre-frail (an intermediate category between frail and non-frail) elderly

J PRIM HEALTH CARE 2015;7(4):269–273.

CORRESPONDENCE TO:
Hirotomo Yamanashi
205, Yoshikugi, Goto, Nagasaki, Japan 853-8691
yamanashi@nagasaki-u.ac.jp

and living alone, but not for frail elderly.[6] No study of an association between frailty and family structures has previously been reported.

The objective of the study was to investigate whether there is an association between living alone and physical frailty among community-dwelling elderly in isolated islands in Japan.

Methods

Study settings and participants

The survey was conducted in the Goto Islands in the western part of Japan, which in 2010 had a population of 40 622 with 13 545 (33.3%) elderly (≥65 years old).[7] The Goto city municipal government has been promoting periodic health check-up examinations for community-dwelling adults to screen for and treat non-communicable diseases since 1982. We approached all individuals aged >60 years who participated in the community-based health check-up examinations in 18 out of 24 community centres on the island between 29 May and 30 June 2014. All eligible participants gave written informed consent.

Medical and social history and frailty

Trained field workers administered a structured interview and recorded family structure, medication use (antihypertensive, hypoglycaemic, and lipid-lowering medications), history of stroke or ischaemic heart disease, smoking, alcohol intake, joint pain or swelling. They also performed the Kessler Psychological Distress Scale (K6).[8] Family structure was classified dichotomously as single household (living alone) or non-single household (living with others). Frailty was measured by a 15-item self-report questionnaire, the Frailty Index for Japanese elderly (FI-J), which has been previously validated in the Japanese population.[9,10] The FI-J has been reported as having a sensitivity and specificity of 70.0% and 89.3% respectively, with the Fried Frailty Model used as the benchmark and the cut-off point for frailty on the FI-J set at a score of greater than 3 points.[10] We used the same definition of frailty in this study, categorising participants with a score of 0 to 3 points on the FI-J as non-frail and those with a score of 4 to 15 as frail.

Physical examination and testing

Body weight and height were measured with an automatic body composition analyser (BF-220; Tanita, Tokyo, Japan). Handgrip strength was recorded as the mean grip strength of two measurements done with each hand using a handgrip dynamometer (Smedley, Matsumiyaika-seikiseisakujo, Tokyo, Japan). The mean value was calculated from four trials. Serum concentrations of triglycerides, low-density lipoprotein cholesterol (LDL), high-density lipoprotein cholesterol (HDL), glycated haemoglobin (HbA1c), creatinine, anti-cyclic citrullinated peptide antibody (anti-CCP), and estimated glomerular filtration rate (eGFR), as defined by the Japanese Chronic Kidney Disease (CKD) initiative, were obtained from the community-based health check-up examinations.[11]

Statistical analysis

Participants were stratified by sex and differences in mean values or frequency of potential confounding factors by frailty were analysed using the Student's *t*-test and Chi-square tests, respectively. Statistical analyses were performed using SAS version 9.4. All *p*-values for statistical tests were two-tailed, and values of <0.05 were regarded as statistically significant. Logistic regression models were used for calculating odds ratios (OR) and 95% confidence intervals (CI) for the association with family structure.

This study was approved by the ethics committee of Nagasaki University (Ref. 14051404).

Results

Characteristics of the study population

One thousand seven hundred and twenty-five (614 men and 1111 women) participated in the community-based health check-up examinations and 1602 aged 29 to 94 years agreed to take part in the present study (participation rate; 92.9%). For this analysis, we excluded 378 individuals with missing data or aged below 60 years, leaving 1224 participants (434 men and 790 women) in this study. The mean age and sex ratio of the total 1725 individuals (67.0 years and male 35.6%)

did not differ significantly from the study 1224 participants (67.3 years and 34.6%). Table 1 shows the baseline characteristics of the participants. In the men, the mean of body mass index (BMI) and the frequency of history of cardiovascular disease, hypertension and diabetes mellitus did not differ by family structure, whereas women living alone were more likely to be older, have less handgrip strength, and to have a higher frequency of hypertension and CKD. Men living alone tended to have higher K6 scores.

WHAT GAP THIS FILLS

What we already know: Demographic changes have resulted in an increasing number of the elderly living alone. This emerging single household structure may have an influence on frailty among the elderly but studies of frailty risk and family structure have shown contradictory results.

What this study adds: In this survey of community-dwelling adults aged 60 years and older in rural, remote islands in Japan, men living alone had a high risk of frailty. Screening and intervention to minimise frailty in the elderly in rural Japan should target men living alone.

Prevalence of frailty in the study population

A total of 38.1% of men living alone were assessed as frail, while only 13.8% of men living with other family members were; 16.8% of women living alone were assessed as frail, compared with 15.8% of those women living with other family members. Men living alone were significantly more likely to be housebound, have fewer hobbies or interests, have impairment of vision, have greater fall hazards in the home, have loss of appetite, and have muscle loss within the last six months than men who lived with other family members. Women living alone were more likely to have fewer friendships (other than

Table 1. Clinical characteristics of the studied population according to household family structure (N=1224)

	Men			Women		
	Living with others (n=392)	Living alone (n=42)	P-value	Living with others (n=552)	Living alone (n=238)	P-value
Age, years	71.7 ± 7.0	73.2 ± 9.2	0.299	70.9 ± 7.1	74.4 ± 7.2	**<0.001**
Height, cm	162.9 ± 6.2	162.8 ± 5.8	0.909	150.4 ± 6.0	150.0 ± 7.1	0.459
Body weight, kg	61.6 ± 9.2	61.2 ± 9.5	0.792	50.9 ± 8.2	51.1 ± 9.0	0.814
Body mass index, kg/m²	23.2 ± 2.9	23.0 ± 2.8	0.752	22.5 ± 3.2	22.7 ± 3.4	0.441
Handgrip strength, kg	32.7 ± 7.1	31.4 ± 9.0	0.360	18.7 ± 4.9	17.3 ± 4.9	**<0.001**
History of stroke	28 (7.1)	2 (4.8)	0.756	15 (2.7)	5 (2.1)	0.613
History of ischaemic heart disease	29 (7.4)	6 (14.3)	0.133	33 (6.0)	20 (8.4)	0.211
Current smoker	66 (16.8)	8 (19.0)	0.717	10 (1.8)	8 (3.4)	0.181
Regular/occasional alcohol consumption	216 (55.1)	25 (59.5)	0.585	69 (12.5)	22 (9.2)	0.167
Hypertension	54 (13.8)	32 (76.2)	0.360	348 (63.0)	169 (71.0)	**0.031**
Diabetes mellitus	45 (11.5)	7 (16.7)	0.608	45 (8.2)	11 (4.6)	0.076
Dyslipidaemia	174 (44.4)	18 (42.9)	0.850	309 (56.0)	130 (54.6)	0.725
Chronic kidney disease	110 (28.1)	12 (28.6)	0.944	147 (26.6)	84 (35.3)	**0.026**
Rheumatoid arthritis	0	0		5 (0.9)	4 (1.7)	0.465
Score on Kessler Psychological Distress Scale (continuous)	1.3 ± 2.4	2.1 ± 4.4	0.225	1.6 ± 2.6	1.7 ± 2.5	0.466
History of separation or death of spouse	10 (2.6)	31 (73.8)	**<0.001**	82 (14.9)	198 (83.2)	**<0.001**

* Data are mean ± standard deviation or n (%). Hypertension: defined as antihypertensive medication use or systolic blood pressure ≥140 mm Hg or diastolic blood pressure ≥90 mm Hg. Diabetes mellitus: defined as hypoglycaemic medication use or HbA1c ≥6.5% (48 mmol/mol). Dyslipidaemia: defined as triglycerides ≥150 mg/dL (1.7 mmol/L) or LDL cholesterol ≥140 mg/dL (3.6 mmol/L) or HDL cholesterol <40 mg/dL (1.0 mmol/L). Chronic kidney disease: defined as eGFR <60 mL/min/1.73m². Rheumatoid arthritis: defined as anti-cyclic citrullinated peptide antibody (anti-CCP) positivity (≥4.5 U/mL) with joint symptoms

neighbours), and were less likely to be able to walk continuously for 1 km (Table 2).

Risk factors for frailty

In univariate analysis, living alone was significantly associated with frailty in men (OR 3.85, 95% CI 1.94–7.65), but not in women (OR 1.08, 95% CI 0.72–1.63). This association in men remained significant after further adjustment for known risk factors used in previous studies: age, BMI, history of stroke or ischaemic heart disease, smoking, alcohol intake, hypertension, diabetes mellitus, dyslipidaemia, CKD, rheumatoid arthritis, and K6 score (OR 3.90, 95% CI 1.83–8.31).

Discussion

Our findings demonstrated a clear association between living alone and frailty in older men, but not in women, even after adjusting for current and past health conditions in the multivariate regression model. Men living alone were shown to be frequently housebound. Fried et al.[3] suggested a vicious cycle of frailty, with several factors correlating with frailty in their model, including chronic malnutrition, muscle wasting, chronic disease, and slower walking speed. Data from the English Longitudinal Study of Ageing (ELSA) showed that the association between BMI and frailty was a U-shaped curve,[12] suggesting that both low BMI and high BMI are a risk for frailty. In our study, however, the mean BMI for men was not as high (23.2 ± 2.9 for men living with other family members and 23.0 ± 2.8 for men living alone). Men with a BMI over 30.0 comprised just 1.4% (6/434) of the men in our sample population. Thus, when we consider the risk of frailty, low BMI is more of a concern for frailty in a Japanese popula-

Table 2. Findings of the Frailty Index for Japanese elderly according to household family structure (N=1224)

		Men			Women		
		Living with others (n=392)	Living alone (n=42)	P-value	Living with others (n=552)	Living alone (n=238)	P-value
FI-J 1	Lower daily physical activity	84 (21.4)	17 (40.5)	**0.006**	159 (28.8)	70 (29.4)	0.863
FI-J 2	Less outdoor activity	12 (3.1)	4 (9.5)	0.058	23 (4.2)	13 (5.5)	0.423
FI-J 3	Fewer hobbies or interests	56 (14.3)	12 (28.6)	**0.016**	121 (21.9)	43 (18.1)	0.221
FI-J 4	Less contact with neighbours	93 (23.7)	15 (35.7)	0.088	96 (17.4)	41 (17.2)	0.955
FI-J 5	Less friendships other than neighbours	43 (11.0)	7 (16.7)	0.305	54 (9.8)	13 (5.5)	**0.046**
FI-J 6	Fall within previous one year	59 (15.1)	6 (14.3)	0.895	96 (17.4)	36 (15.1)	0.434
FI-J 7	Unable to walk continuously for 1 km	40 (10.2)	7 (16.7)	0.195	89 (16.1)	60 (25.2)	**0.003**
FI-J 8	Visual impairment	24 (6.1)	7 (16.7)	**0.021**	29 (5.3)	12 (5.0)	0.902
FI-J 9	Fall hazards in the home	41 (10.5)	12 (28.6)	**0.001**	84 (15.2)	37 (15.5)	0.906
FI-J 10	Fear of falls	8 (2.0)	2 (4.8)	0.251	16 (2.9)	5 (2.1)	0.523
FI-J 11	Hospital admission within previous one year	53 (13.5)	6 (14.3)	0.891	33 (6.0)	19 (7.9)	0.297
FI-J 12	Loss of appetite	9 (2.3)	4 (9.5)	**0.029**	20 (3.6)	4 (1.7)	0.144
FI-J 13	Difficulty with mastication (chewing)	22 (5.6)	2 (4.8)	1.000	32 (5.8)	21 (8.8)	0.119
FI-J 14	Weight loss over 3 kg within 6 months	35 (8.9)	5 (11.9)	0.571	46 (8.3)	14 (5.9)	0.233
FI-J 15	Muscle loss within 6 months	84 (21.4)	15 (35.7)	**0.036**	118 (21.4)	42 (17.6)	0.231
FI-J (>3)	Frail	54 (13.8)	16 (38.1)	**<0.001**	87 (15.8)	40 (16.8)	0.714

FI-J Frailty Index for Japanese elderly

* Data are n (%)

tion. Nutrition status, as estimated by BMI, and handgrip strength as a marker of muscle wasting were not significantly different in men by household status in our population. This suggests that a sedentary lifestyle in men living alone is possibly a greater contributor to frailty.

Depressive symptoms are a risk factor for frailty,[3] and we assessed this using the K6. The K6 score was higher in men living alone compared with those living with other family members, although this was not statistically significant. Men with a history of bereavement had higher K6 scores compared with those without a history of bereavement in this study (2.3 vs 1.3, age-adjusted p=0.048 using ANOVA), whereas female subjects did not differ (1.65 vs 1.53, age-adjusted p=0.470). Another possible explanation for the risk of frailty in men living alone may be mental distress after separation or death of a spouse.

It takes time to evaluate frailty.[13] Our findings suggest simple questions about household structure can help identify those at high risk of frailty. A programme to target men living alone who have a low level of daily physical activity and who have mental health problems could help reduce levels of frailty in this group.[14]

Study limitations

The cross-sectional observational design of this study can only demonstrate associations and cannot infer causal relationships. Participants were recruited during their health check-up examination, so there may be sampling bias. People who were frail, or not motivated to seek preventive health checks may have been less likely to participate in the study if they lived alone compared with those in households where other family members might take them to the health check-up. However, these factors would reduce the observed associations we found. A further limitation of the study is the use of a self-report questionnaire (FI-J). Recent studies have indicated that, compared with objective measures (such as accelerometers), self-report measures overestimated the level of physical activity, probably due to recall bias, giving socially desirable responses, and the influence of factors such as mood and cognition.[15,16]

Final comments

Men living alone in rural Nagasaki had a higher risk of frailty compared with men living in a household with other family members. Targeting this high-risk population may be useful to minimise frailty in the community.

References

1. Japanese Ministry of Health, Labour and Welfare. Health Statistics 2010. 2010. [Cited 2015 Feb 4]. Available from: www.mhlw.go.jp/toukei/saikin/hw/hoken/national/dl/22-00.pdf
2. Japanese Ministry of Health, Labour and Welfare. Survey of long-term care benefit expenditures. 2012. [Cited 2015 Feb 4]. Available from:www.mhlw.go.jp/topics/kaigo/osirase/jigyo/12/
3. Fried LP, Tangen CM, Walston J, Newman AB, Hirsch C, Gottdiener J, et al. Frailty in older adults: evidence for a phenotype. J Gerontol A Biol Sci Med Sci. 2001;56(3):M146–56.
4. Japanese Ministry of International Affairs and Communications. Population Estimates. 2013. [Cited 2015 Feb 4]. Available from: www.stat.go.jp/data/jinsui/2013np/index.htm
5. Japanese Ministry of Health, Labour and Welfare. Comprehensive survey of living conditions. 2011. [Cited 2015 Feb 4]. Available from: http://www.mhlw.go.jp/english/database/db-hss/cslc-index.html
6. Sánchez-García S, Sánchez-Arenas R, García-Peña C, Rosas-Carrasco O, Avila-Funes JA, Ruiz-Arregui L, et al. Frailty among community-dwelling elderly Mexican people: prevalence and association with sociodemographic characteristics, health state and the use of health services. Geriatr Gerontol Int. 2014;14(2):395–402.
7. Municipal Borough of Goto, Nagasaki, Japan. Statistics for Goto. 2013. [Cited 2015 Feb 4]. Available from: www3.city.goto.nagasaki.jp/contents/city_ad/index237.php
8. Kessler RC, Green JG, Gruber MJ, Sampson NA, Bromet E, Cuitan M, et al. Screening for serious mental illness in the general population with the K6 screening scale. Int J Methods Psychiatr Res. 2010;19:4–22.
9. Yoshida H, Nishi M, Watanabe N, Fujiwara Y, Fukaya T, Ogawa K, et al. Predictors of frailty development in a general population of older adults in Japan using the Frailty Index for Japanese elderly patients. [In Japanese]. Nihon Ronen Igakkai Zasshi. 2012;49(4):442–8.
10. Shinkai S, Watanabe N, Yoshida H, Fujiwara Y, Nishi M, Fukaya T, et al. Validity of the Kaigo-Yobo Check-List as a frailty index. [In Japanese]. Nihon Koshu Eisei Zasshi. 2013;60(5):262–74.
11. Nakamura K, Okamura T, Hayakawa T, Hozawa A, Kadowaki T, Murakami Y, et al. The proportion of individuals with alcohol-induced hypertension among total hypertensives in a general Japanese population: NIPPON DATA90. Hypertens Res. 2007;30:663–68.
12. Hubbard R, Lang I, Llewellyn D, Rockwood K. Frailty, body mass index, and abdominal obesity in older people. J Gerontol A Biol Sci Med Sci. 2010;65(4):377–81.
13. Clegg A, Young J, Iliffe S, Rikkert MO, Rockwood K. Frailty in elderly people. Lancet. 2013;381(9868):752–62.
14. Cesari M, Vellas B, Hsu F, Newman A, Doss H, King A, et al. A physical activity intervention to treat the frailty syndrome in older persons—Results from the LIFE-P study. J Gerontol A Biol Sci Med Sci. 2015;70(2):216–22.
15. Jansen F, Prins R, Etman A, Van der Ploeg H, de Vries S, van Lenthe F, et al. Physical activity in non-frail and frail older adults. PLoS One. 2015;10(4):e0123168.
16. Tucker J, Welk G, Beyler N. Physical activity in U.S.: adults compliance with the Physical Activity Guidelines for Americans. Am J Prev Med. 2011;40(4):454–61.

ACKNOWLEDGEMENTS
The authors would like to thank the members of the Goto city office division of public health who helped with community health check-up examinations, and all those who participated in this study.

FUNDING
The study was funded by a Grant-in-Aid for Scientific Research from the Japan Society for the Promotion of Science (No. 22370090).

COMPETING INTERESTS
None declared.