


Mediating role of instrumental activities of daily living ability on cognitive function of older adults living alone

A 4-year longitudinal study from the Kasama study

Keisuke Fujii, OTR, PhD^{a,*} , Yuya Fujii, PhD^b, Naruki Kitano, PhD^c, Ayane Sato, PhD^d, Kazushi Hotta, OTR, PhD^e, Tomohiro Okura, PhD^{f,g}

Abstract

The aim of this study was to clarify the effect of living alone on the cognitive function of older people and the mediating effect of instrumental activities of daily living (IADL) ability.

The data for a final sample of 3276 participants aged 65 years and above who did not require long-term care at the baseline were used from a 4-year prospective cohort study conducted in Kasama City, Japan. Demographic data including age, sex, and depression at baseline were used as covariates. The Kihon checklist evaluated the IADL ability at baseline and cognitive function at follow-up. The characteristics of those living alone and with others were compared using the student *t* test and χ^2 test. The effect of living alone on cognitive function was analyzed using logistic regression analysis. Mediation analyses determined the mediating effects of IADL.

A total of 325 participants were living alone; they were significantly older than those living with others, more likely to be female, not provide emotional support, and have low physical function, more severe depression, and lower IADL disability. Living alone had a significantly lower risk of cognitive decline at follow-up than living with others. The mediation analysis revealed that IADL disability at follow-up was significantly associated with cognitive decline. Thus, greater IADL ability decreased cognitive decline risk.

Older people living alone had a significantly lower risk of cognitive decline, and cognitive function significantly mediated IADL ability. Health support for enhancing IADL abilities may help older people living alone maintain good cognitive function.

Abbreviations: BMI = body mass index, CI = confidence interval, DV = dependent variable, IADL = instrumental activities of daily living, IV = independent variable, KCL = Kihon check list, MCI = mild cognitive impairment, MV = mediation variable, OR = odds ratio, Ref = reference.

Keywords: activities of daily living, cognitive dysfunction, Japanese older people, longitudinal data, residence characteristics

1. Introduction

In Japan, the number of older people living alone has been increasing rapidly due to changes in household composition. In particular, there is a growing aging and lifetime unmarried population. These figures will continue to increase, and it is estimated that more than one-third of households with older

people will become single households by 2030. The proportion of older people living alone is an increasing, and major problem in Japan and around the world.

Previous studies revealed that older people living alone have a higher risk of depression than those living with others.^[1,2] However, there are few reports on cognitive function. For

Editor: Ning Zhang.

Funding: This study was supported by the Ministry of Education, Culture, Sports, Science and Technology of Japan, Grant-in-Aid for Scientific Research (B), 25282213, 2013–2015 and by the Mitsui Sumitomo Insurance Welfare Foundation, 2016.

The authors report no conflicts of interest.

Supplemental Digital Content is available for this article.

The datasets generated during and/or analyzed during the current study are publicly available.

^aDepartment of Occupational Therapy, Faculty of Health Sciences, Kansai University of Health Sciences, Sennan, Osaka, Japan, ^bPhysical Fitness Research Institute, Meiji Yasuda Life Foundation of Health and Welfare, Hachioji, Tokyo, Japan, ^cPhysical Fitness Research Institute, Meiji Yasuda Life Foundation of Health and Welfare, Hachioji, Tokyo, Japan, ^dFaculty of Regional Collaboration, Kochi University, Kochi, Japan, ^eDepartment of Occupational Therapy, Faculty of Health Sciences, Ibaraki Prefectural University of Health Sciences, Inashiki, Ibaraki, Japan, ^fFaculty of Health and Sport Sciences, University of Tsukuba, Tsukuba, Ibaraki, Japan, ^gR&D Center for Tailor-Made QOL, University of Tsukuba, Tsukuba, Ibaraki, Japan.

*Correspondence: Keisuke Fujii, Department of Occupational Therapy, Faculty of Health Sciences, Kansai University of Health Sciences, 2-11-1 Kumatori, Sennan, Osaka 590-0482, Japan (e-mail: k.fujii@kansai.ac.jp).

Copyright © 2021 the Author(s). Published by Wolters Kluwer Health, Inc.

This is an open access article distributed under the terms of the Creative Commons Attribution-Non Commercial License 4.0 (CCBY-NC), where it is permissible to download, share, remix, transform, and buildup the work provided it is properly cited. The work cannot be used commercially without permission from the journal.

How to cite this article: Fujii K, Fujii Y, Kitano N, Sato A, Hotta K, Okura T. Mediating role of instrumental activities of daily living ability on cognitive function of older adults living alone: a 4-year longitudinal study from the Kasama study. *Medicine* 2021;100:40(e27416).

Received: 5 February 2021 / Received in final form: 11 August 2021 / Accepted: 14 September 2021

<http://dx.doi.org/10.1097/MD.00000000000027416>

example, previous reports from a 2-year longitudinal study of 1498 individuals (430 individuals who lived alone) indicated that older people living alone were not associated with poor cognitive function.^[3] The Finland, Italy, the Netherlands Elderly (FINE) Study reported in a 10-year longitudinal study of 1030 males (88 individuals who lived alone) that older people living alone had more prominent cognitive decline than those living with others.^[4] However, previous studies had issues, such as being limited to male participants only, having a short follow-up period, and recruiting a small sample of older living alone. In addition, no consensus was obtained about the effects of older people living alone on cognitive function, and no study has been conducted on elderly Japanese people. Therefore, our group conducted a postal survey of 10,339 community-dwelling people aged ≥ 65 years and conducted a cross-sectional study comparing physical function, cognitive function, and depression among older people living alone and those living with others. The results showed that on the one hand, older people living alone were significantly more likely to have depression; however, on the other hand, they were significantly less likely to have cognitive decline, and there was no difference in physical function.^[5]

There is evidence from many previous studies that older people living alone have a higher risk of depression. However, why is the cognitive function of the older people living alone better? Living alone is consistently identified as a risk for dementia.^[6,7] Ultimately, the current evidence for cognitive outcomes among older people living alone may not necessarily have a negative effect. Under these circumstances, we believe that one of the reasons this group has good cognitive function is its instrumental activity of daily living (IADL) ability. Previous studies have reported that older people living alone maintain good IADL ability.^[8,9] IADL abilities are routine activities, but they are more goal-oriented and related to complex and higher functional abilities such as preparing a meal, handling finances, shopping, and other activities.^[10–12] It has also been reported that a lower IADL ability is associated with mild cognitive impairment. Therefore, IADL ability may be associated with cognitive function.^[13,14] In addition, older people living alone cannot live without IADL on their own. These results suggest that older people living alone have a lower rate of cognitive decline compared to those living with others. Thus, a higher IADL ability may contribute to better cognitive function in older individuals living alone.

However, the effects of living alone on cognitive function have not been considered longitudinally in Japan, and there has been no study on whether IADL ability can be a mediating factor. Older people living alone may have better cognitive function, but they also have a rapid decline in function when a disability or illness occurs when compared to those living with others.^[15] Therefore, older people living alone need to prioritize preventative care. The aim of this study was to clarify the effect of living alone on cognitive function of older people using a 4-year longitudinal study and to clarify the mediating effect of IADL ability. This study is very important in examining health support methods for preventing cognitive decline among older people living alone, especially given that their numbers will continue to increase in the future.

2. Materials and methods

2.1. Participants and data collection

This study was a 4-year prospective cohort study the “Kasama Study” conducted in Kasama City, Ibaraki Prefecture, Japan.

Kasama City is a rural, agricultural area and is categorized as a flatland agricultural region and intermediate agricultural region. See the previous study for a detailed explanation of the Kasama study.^[16]

Figure 1 shows the flowchart of the participant. Participants in this prospective cohort study were all aged ≥ 65 years who were not certified as requiring long-term care as of June 2013. In June 2013, a self-administered questionnaire baseline survey was mailed to 16,870 community-dwelling older people. Responses were obtained from 10,339 persons (recovery rate: 61.1%). After that, we excluded those who died, had an incident of functional disability, or moved out of the city during the follow-up period. In August 2017, a follow-up survey with the same content was conducted among 8418 participants. As a result, responses were obtained from 6279 people. Of these, an additional 3003 participants were excluded: those who had missing data in household composition at the baseline survey; those who had a change in household composition at the baseline survey and at the follow-up survey; those who had a history of dementia, or psychiatric disorder at the baseline survey; those who had cognitive decline at the baseline survey; and those who filled out incomplete questionnaires. In the end, 3276 participants were included in the final analysis. All participants were informed of the details of the study and provided informed consent. This study protocol was approved by the Ethical Committee of the University of Tsukuba.

2.2. Measurement variables

Demographic data including sex, age, educational history, subjective economic status, body mass index (BMI), receiving and providing emotional support, physical function, and depression at baseline were used as covariates. Subjective economic status was assessed with the question, “How do you feel about your current economic situation?” Answers were obtained using the 5 items “Very difficult,” “Slightly difficult,” “Normal,” “Somewhat rich,” and “Very rich.” Receiving and providing emotional support was evaluated using 2 items in the Kihon Check List (KCL),^[17] a comprehensive, self-reported health checklist developed by the Japanese Ministry of Health, Labour and Welfare. The 2 items were as follows: “Do you ever visit a friend’s home?” and “Do you have someone with whom you can talk when you are in trouble?” Physical function was evaluated using the 5 items of “Physical function” (score 0–5) in the Kihon Check List.^[17] The 5 items were as follows: “Are you able to go upstairs without using handrails or the wall for support?”; “Are you able to stand up from a sitting position without support?”; “Are you able to walk continuously for 15 minutes?”; “Have you experienced a fall in the past year?”; and “Do you feel anxious about falling when you walk?” The category “Low physical strength” referred to older people who had ≥ 3 negative responses.” Depression was evaluated using the 5 items of “Depression” (score 0–5) in the KCL.^[17] The 5 items were as follows, and participants recalled information from the previous 2 weeks: “You feel no sense of fulfillment in your life,” “You cannot enjoy things that you enjoyed before,” “Things that you could do easily before are now difficult,” “You do not feel that you are a useful person,” and “You feel exhausted for no apparent reason.” The term “depression” referred to older people who had ≥ 2 negative responses.”

Living arrangement was categorized as living alone or living with others. IADL ability at baseline was evaluated using the 3

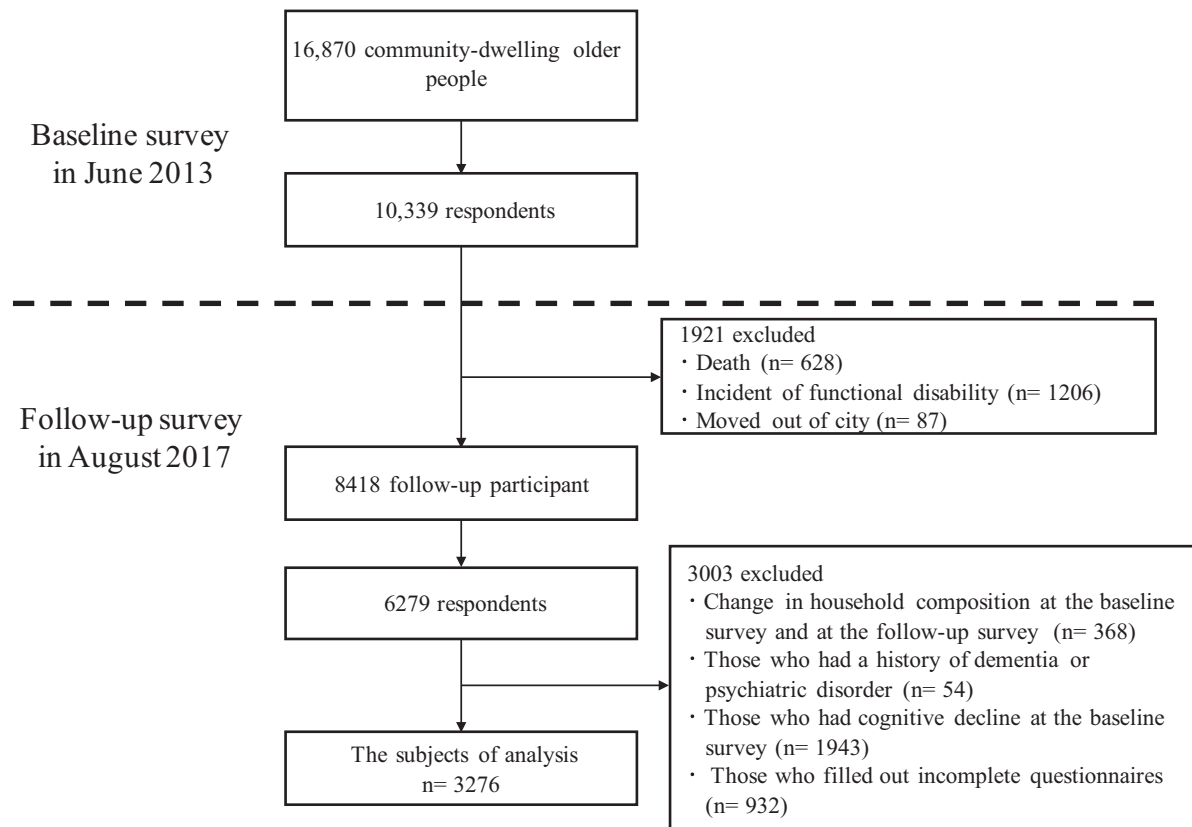


Figure 1. Flowchart of the participants.

items of “IADL ability” (score 0–3) in the KCL.^[17] The 3 items were as follows: “Do you use public transportation (bus or train) to go out on your own?”; “Do you shop for daily necessities?”; and “Do you manage financial matters such as savings or deposits by yourself?” Based on those responses, “IADL disability” referred to older people who had ≥ 1 negative response(s).^[18]

Cognitive function at follow-up was evaluated using the 3 items of the “Cognitive function” (score 0–3) in the KCL.^[17,19,20] The 3 items were as follows: Do others point out your forgetfulness or tell you “You always ask the same thing;” “When you want to make a call, do you usually search for the telephone number and call on your own?”; and “Do you sometimes not know what the date is?” Here, “cognitive decline” referred to older people who had one or more negative responses.” This evaluation method has been confirmed to relate to the onset of dementia in previous studies.^[20]

2.3. Statistical analysis

We performed a normality test on the baseline continuous variables, and we confirmed that they were not normally distributed. Therefore, we calculated medians, maximums, and minimums for the continuous variables as well as the frequencies and percentages for categorical variables at baseline. The Mann–Whitney t test and χ^2 test were used to compare the characteristics of those living alone and those living with others. To examine the effect of living alone on cognitive function for older people, we performed a logistic regression analysis with cognitive

decline at follow-up as a dependent variable and living arrangement as an independent variable. Next, mediation analyses were used to determine whether IADL ability mediates the association of living arrangement with cognitive decline. Mediation analysis was performed according to the method of Baron and Kenny.^[21] First, the association of living arrangement with cognitive decline at follow-up was examined with logistic regression (total effect). This step was similar to the analysis that examined the effect of living alone on cognitive function for older people. Second, the association between living arrangement and IADL disability was tested by using a logistic regression analysis. Third, we performed a logistic regression analysis that included living arrangement and IADL disability simultaneously as dependent variables, and cognitive decline at follow-up as dependent variables (direct effect). Fourth, the Sobel test was used to examine indirect effect, and IADL ability was considered a mediator when there was a significant indirect effect. We used 2 models in this study: a crude model and adjusted model. The latter was adjusted for age (continuous), sex (categorical), education history (categorical), subjective economic status (categorical), BMI (continuous), providing and receiving emotional support (categorical), low physical strength (categorical), and depression (categorical) using the baseline survey. These covariates were selected as potential factors from previous studies.

Student t test, χ^2 test, and logistic regression analyses were performed using IBM SPSS 25.0 (IBM Corp., Armonk, NY). The Sobel test was conducted by using an interactive calculation tool for mediation tests (<http://quantpsy.org/sobel/sobel.htm>). In all

Table 1
Participants' characteristics.

	Living alone (n = 325) % (n)	Living with others (n = 2951) %(n)	P
Age, y, median (max-min)	73 (65–94)	71 (65–97)	<.001
Female	71.1 (231)	49.9 (1473)	<.001
Education history (\geq high school)	70.8 (230)	74.9 (1473)	.106
Subjective economic status (poor)	16.0 (52)	13.5 (399)	.218
Body mass index, kg/m ² , median (max–min)	22.8 (14.3–34.7)	22.9 (14.5–35.8)	.430
Medical history			
Diabetes (have)	10.5 (34)	13.0 (384)	.191
Stroke (have)	3.4 (11)	2.6 (78)	.435
Providing emotional support (no)	12.9 (42)	7.1 (209)	<.001
Receiving emotional support (no)	5.5 (18)	6.0 (176)	.758
Low physical function (have)	14.5 (47)	10.0 (296)	.013
Depression (have)	16.0 (52)	11.8 (348)	.028
IADL disability (have)	8.0 (26)	18.3 (540)	<.001
Cognitive decline* (have)	20.3 (66)	24.9 (735)	.067

IADL = instrumental activities of daily living.

*Result of follow-up period.

analyses, a *P* value of <.05 was considered to indicate statistical significance.

3. Results

The comparison of characteristics between those living alone and those living with others is shown in Table 1. The number of people living alone was 325 persons (10.0%), and as a group, they were significantly older than those living with others, and significantly more likely to be female, not providing emotional support, with low physical strength, and depressed. However, those living alone had a significantly lower IADL disability than those living with others.

Table 2 shows the effect of living alone on cognitive function. In the crude model, those living alone had a lower risk of cognitive decline 4 years later than those living with others, but there was no statistically significant difference (odds ratio [OR] = 0.77; 95% confidence interval [CI], 0.58–1.02; *P* = .068). In the adjusted model, living alone had a significantly lower risk of cognitive decline 4 years later than living with others (OR = 0.70; 95% CI 0.53–0.93; *P* = .016), and this result was the total effect of living alone on cognitive decline.

Table 3 summarizes the results of mediation analysis for cognitive decline at follow-up. Figure 2 shows the results of the adjusted model. In the adjusted model, there was a significant association between living arrangement and IADL disability at follow-up (OR = 0.54; 95% CI 0.35–0.83; *P* < .001). Analysis of direct effects showed significant association between living

arrangement and cognitive decline at follow-up (OR = 0.70; 95% CI 0.53–0.93; *P* = .033), IADL disability at follow-up was significantly associated with cognitive decline at follow-up (OR = 1.34; 95% CI 1.09–1.66; *P* = .005)—that is, living arrangement was significantly associated with cognitive decline at follow-up in this model, a greater IADL ability correlated with a decreased cognitive decline risk. In the adjusted model, the Sobel test for indirect effect was statistically significant (*P* = .001). The results of the mediation analysis of the crude model were similar to those of the adjusted model.

4. Discussion and conclusions

This study investigated the effect of living alone on cognitive function among Japanese older people using a large-scale survey and examined the mediating effect of IADL ability. The results showed that living alone correlated with a significantly lower odds ratio for cognitive decline at follow-up at 4 years compared to those living with others. In addition, we found that cognitive function mediates IADL ability. To date, there have been few longitudinal studies of cognitive function among older people living alone, and no study has been conducted on Japanese older people. Therefore, this is the first study to clarify whether IADL ability mediates the maintenance of cognitive function among older people who live alone.

Previous cross-sectional studies have shown that older people living alone have a significantly lower odds ratio for cognitive decline.^[5] Our results support previous studies. In addition, a

Table 2
The effect of living alone on cognitive decline.

	Crude model			Adjusted model		
	OR	95% CI	P	OR	95% CI	P
Living with others	Ref.			Ref.		
Living alone	0.77	0.58–1.02	.068	0.70	0.53–0.93	.016

CI = confidence interval, OR = odds ratio, Ref = reference.

Adjusted model was adjusted for age, sex, education history, subjective economic status, body mass index, medical history (diabetes, stroke), providing emotional support, receiving emotional support, physical function, and depression.

Table 3
Mediation model for living arrangement and instrumental activities of daily living.

	Living alone (IV) → IADL disability (MV)			IADL disability (MV) → Cognitive decline (DV)			Living alone (IV), IADL disability (MV) → Cognitive decline (DV)			Sobel test P
	OR	95%CI	P	OR	95%CI	P	OR	95%CI	P	
Crude model	0.39	0.26–0.59	P<.001	1.54	1.26–1.88	P<.001	0.80	0.61–1.07	.132	.002
Adjusted model	0.54	0.35–0.83	P<.001	1.34	1.09–1.66	.005	0.70	0.53–0.93	.033	.001

CI = confidence interval; DV = dependent variable; IADL = instrumental activities of daily living; IV = independent variable; MV = mediation variable; OR = odds ratio. Adjusted model was adjusted for age, sex, education history, subjective economic status, body mass index, medical history (diabetes, stroke), providing emotional support, receiving emotional support, physical function, and depression.

better study design, such as a longitudinal study, suggested that older people living alone might have a decreased risk of cognitive decline. Previous studies have suggested that older people living alone had better IADL ability.^[8,9] IADL ability is a higher level of function than activities of daily living, and in recent years, it has also been reported to be associated with mild cognitive impairment,^[13,14] which is considered the preliminary stage of dementia. Among those living with others, even if they do not perform IADL activities alone, someone can do it for them. However, if older people living alone cannot perform IADL activities, they cannot conduct their daily lives. In fact, older people living alone had a significantly higher rate of good IADL abilities than those living with others in this study. Therefore, it is possible that the older people who live alone had good cognitive function because they maintained good IADL ability compared to those living with others. In addition, mediation analysis showed that IADL ability was significantly mediated for the effect of living alone on cognitive function for older people. Therefore, older people living alone should perform minimum IADL to live and maintaining their IADL ability may have an indirect effect of maintaining cognitive functions better than those living with others.

This study also had several limitations. First, this study included individuals who were able to respond to a questionnaire survey over the 2 measurement periods at the baseline and 4-year follow-up. It can be speculated that the participants of this study had cognitive function levels that allowed them to answer the questionnaire, and a certain number of participants had cognitive

function levels that were difficult to answer. The results should be interpreted with caution because older people living alone who were cognitively impaired may have avoided certain answers, and, in the case of those living with others who had cognitive decline, it is possible that the person living with them responded instead. As a result, the risk of cognitive decline among older people living alone cannot be denied. The results comparing the participants in the final analysis with the excluded participants are attached as Supplemental Digital Content (Appendix 1, <http://links.lww.com/MD/G433>). The results show that most of the excluded participants have significantly poorer health status, which suggests that selection bias cannot be ruled out. However, we did not find any association with household composition among those who were excluded due to cognitive decline at baseline (n=1943) (Supplemental Digital Content [Appendix 2, <http://links.lww.com/MD/G434>]). Second, there are potential factors that this study did not consider. For example, physical activity, social activity, and marital status are factors that have been reported to relate to cognitive function. Third, this study was limited to a single region. The generalization of the results requires a similar study in other regions and urban areas.

A 4-year longitudinal study revealed that older people living alone had a significantly lower risk of cognitive decline than those living with others. In addition, IADL ability significantly mediated cognitive function among those living alone. Healthcare support focusing on IADL abilities among older people living alone may contribute to the maintenance of good cognitive function.

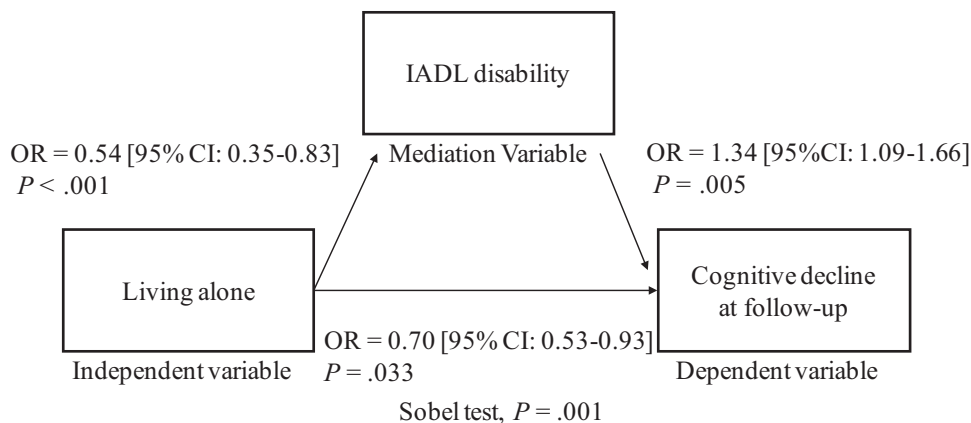


Figure 2. Mediation model for living arrangement, instrumental activities of daily living, and cognitive decline. The model was adjusted for age, sex, body mass index, education history, medical history (diabetes, stroke), providing emotional support, receiving emotional support, low physical strength, and depression. CI = confidence interval, OR = odds ratio.

Acknowledgments

The authors are grateful to the participants and our staff members.

Author contributions

Conceptualization: Keisuke Fujii and Tomohiro Okura.

Data curation: Keisuke Fujii, Yuya Fujii and Tomohiro Okura.

Formal analysis: Keisuke Fujii, Yuya Fujii, Naruki Kitano and Kazushi Hotta.

Funding acquisition: Keisuke Fujii and Tomohiro Okura.

Investigation: Keisuke Fujii, Yuya Fujii and Ayane Sato.

Methodology: Keisuke Fujii, Yuya Fujii, Naruki Kitano and Kazushi Hotta, Tomohiro Okura.

Project administration: Keisuke Fujii and Tomohiro Okura.

Supervision: Kazushi Hotta and Tomohiro Okura.

Writing – original draft: Keisuke Fujii

Writing – review & editing: Yuya Fujii, Naruki Kitano, Ayane Sato, Kazushi Hotta and Tomohiro Okura.

References

- [1] Fukunaga R, Abe Y, Nakagawa Y, Koyama A, Fujise N, Ikeda M. Living alone is associated with depression among the elderly in a rural community in Japan. *Psychogeriatrics* 2012;12:179–85.
- [2] Kikuchi H, Takamiya T, Odagiri Y, et al. Gender differences in association between psychological distress and detailed living arrangements among Japanese older adults, aged 65-74 years. *Soc Psychiatr Epidemiol* 2014;49:823–30.
- [3] Evans IEM, Llewellyn DJ, Matthews FE, et al. Living alone and cognitive function in later life. *Arch Gerontol Geriatr* 2019;81:222–33.
- [4] van Gelder BM, Tijhuis M, Kalmijn S, Giampaoli S, Nissinen A, Kromhout D. Marital status and living situation during a 5-year period are associated with a subsequent 10-year cognitive decline in older men: the FINE Study. *J Gerontol B Psychol Sci Soc Sci* 2006;61:P213–9.
- [5] Fujii K, Sato A, Jindo T, Kitano N, Fujii Y, Okura T. Comparison of physical and cognitive function and depression between older adults living alone and with others in rural area of Japan: a large-scale mail survey of the Kasama Study. *J Educ Health Sci* 2019;64:251–9.
- [6] Fratiglioni L, Wang H-X, Ericsson K, Maytan M, Winblad B. Influence of social network on occurrence of dementia: a community-based longitudinal study. *Lancet* 2000;355:1315–9.
- [7] Holwerda TJ, Deeg DJH, Beekman ATF, et al. Feelings of loneliness, but not social isolation, predict dementia onset: results from the Amsterdam Study of the Elderly (AMSTEL). *J Neurol Neurosurg Psychiatry* 2014;85:135.
- [8] Magaziner J, Cadigan DA, Hebel JR, Parry RE. Health and living arrangements among older women: does living alone increase the risk of illness? *J Gerontol* 1988;43:M127–33.
- [9] Yoshimitsu K, Iwase Y, Kubota M, Ikeda Y. Living conditions of the elderly living alone in rural areas and the influence of instrumental support on individuals without long-term care insurance. *Jpn Occup Ther Res* 2015;34:384–92.
- [10] Bucks RS, Ashworth DL, Wilcock GK, Siegfried K. Assessment of activities of daily living in dementia: development of the Bristol Activities of Daily Living Scale. *Age Ageing* 1996;25:113–20.
- [11] Fujiwara Y, Yoshida H, Amano H, et al. Predictors of improvement or decline in instrumental activities of daily living among community-dwelling older Japanese. *Gerontology* 2008;54:373–80. doi: 10.1159/000151221.
- [12] Lawton MP, Brody EM. Assessment of older people: Self-maintaining and instrumental activities of daily living. *Gerontologist* 1969;9:179–86.
- [13] Perneckzy R, Pohl C, Sorg C, et al. Impairment of activities of daily living requiring memory or complex reasoning as part of the MCI syndrome. *Int J Geriatr Psychiatry* 2006;21:158–62.
- [14] Rodakowski J, Skidmore ER, Reynolds CF3rd, et al. Can performance on daily activities discriminate between older adults with normal cognitive function and those with mild cognitive impairment? *J Am Geriatr Soc* 2014;62:1347–52.
- [15] Sarwari AR, Fredman L, Langenberg P, Magaziner J. Prospective study on the relation between living arrangement and change in functional health status of elderly women. *Am J Epidemiol* 1998;147:370–8.
- [16] Okura T, Tsuji T, Tsunoda K, et al. Study protocol and overview of the Kasama Study: creating a comprehensive, community-based system for preventive nursing care and supporting successful aging. *J Phys Fit Sports Med* 2017;6:49–57.
- [17] Fukutomi E, Okumiya K, Wada T, et al. Importance of cognitive assessment as part of the “Kihon Checklist” developed by the Japanese Ministry of Health, Labor and Welfare for prediction of frailty at a 2-year follow up. *Geriatr Gerontol Int* 2013;13:654–62.
- [18] Makizako H, Shimada H, Doi T, et al. Cognitive functioning and walking speed in older adults as predictors of limitations in self-reported instrumental activity of daily living: prospective findings from the Obu Study of Health Promotion for the Elderly. *Int J Environ Res Public Health* 2015;12:3002–13.
- [19] Meguro KT. The validity of the Basic Checklist in the old-old population: The Kurihara Project. *Jpn J Geriatr Psychiatry* 2012;23:725–30.
- [20] Tomata Y, Sugiyama K, Kaiho Y, Sugawara Y, Hozawa A, Tsuji I. Predictive ability of a simple subjective memory complaints scale for incident dementia: evaluation of Japan’s national checklist, the “Kihon Checklist”. *Geriatr Gerontol Int* 2017;17:1300–5.
- [21] MacKinnon DP, Fairchild AJ, Fritz MS. Mediation analysis. *Annu Rev Psychol* 2007;58:593–614.