

RESEARCH

Open Access



Cooking skills, living alone, and mortality: JAGES cohort study

Yukako Tani^{1*}, Takeo Fujiwara¹, Tatsuhiko Anzai² and Katsunori Kondo^{3,4}

Abstract

Background Living alone without someone to cook meals for them can happen more frequently in aging due to bereavement, divorce, or other family changes. Health risks to older adults due to poor cooking skills may be more pronounced among those living alone. We aimed to examine whether cooking skills are associated with mortality according to cohabitation status in older Japanese people.

Methods Participants in the Japan Gerontological Evaluation Study, a population-based cohort of independent older adults, were followed for three years (n = 10,647). Cooking skill was assessed using a scale with good validity and modified for Japanese people in the baseline survey. After stratification by living alone or together, participants with high and low cooking skills were matched on demographic, socioeconomic, health-related factors, and availability of food stores using propensity score matching. All-cause mortality risks were compared between high and low cooking skills using Cox regression models.

Results During the follow-up, 520 of the 10,647 participants died. One hundred and seventy-one pairs of high and low cooking skills were matched among those living alone, and 2,161 pairs among those living with others were matched as well. The hazard ratio of the low level of cooking skills (vs. high) was 2.50 (95% confidence interval [CI]: 1.10–5.68) among those living alone, while 1.05 (95% CI: 0.82–1.33) among those living with others.

Conclusion Lower cooking skills were associated with a higher risk of mortality only among those living alone. Cooking skills may be important for older adults who live alone to reduce mortality risk.

Keywords Cooking skills, Living alone, Mortality, Older adults, Japan

Introduction

Over the past 50 years, people in developed countries have shifted to eating out and home cooking has declined [1–3]. Evidence of the benefits of home cooking is accumulating, with reports of higher vegetable and fruit consumption, higher nutrient intake, and higher dietary quality [4, 5]. Therefore, there have been calls to return to home cooking to prevent chronic diet-related diseases [6]. Lifestyle changes caused by the coronavirus disease 2019 (COVID-19) pandemic unintentionally prompted an increase in home cooking [7, 8]. However, changes brought about by the pandemic also increased the consumption of unhealthy foods such as processed foods,

*Correspondence:

Yukako Tani
tani.hlth@tmd.ac.jp

¹Department of Global Health Promotion, Tokyo Medical and Dental University (TMDU), 1-5-45, Yushima, Bunkyo-ku, Tokyo 113-8510, Japan

²Department of Biostatistics, M&D Data Science Center, Tokyo Medical and Dental University, 1-5-45 Yushima, Bunkyo-ku, Tokyo 113-8510, Japan

³Department of Social Preventive Medical Sciences, Center for Preventive Medical Sciences, Chiba University, 1-8-1 Inohana, Chuo-ku, Chiba-shi, Chiba 260-8672, Japan

⁴Department of Gerontological Evaluation, Center for Gerontology and Social Science, National National Center for Geriatrics and Gerontology, 7-430 Morikoka-cho, Obu-shi, Aichi 474-8511, Japan



© The Author(s) 2023. **Open Access** This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>. The Creative Commons Public Domain Dedication waiver (<http://creativecommons.org/publicdomain/zero/1.0/>) applies to the data made available in this article, unless otherwise stated in a credit line to the data.

fried food, and snack foods [7, 8]. This suggests that the pandemic has forced home cooking, but that the benefits of home cooking have not been well received. This may be due to the inclusion of convenient processed foods in-home meal preparation, [9] which have a negative consequence on health [10]. Therefore, it is important to encourage more preparation from basic ingredients with minimal processing and less use of convenient processed foods.

Cooking skill is probably one of the most important factors that could encourage cooking from basic ingredients. A qualitative study conducted on adults showed that facilitators of cooking were high self-efficacy in cooking skills and the ability to plan and prepare meals [11]. In cross-sectional studies conducted on adults including those aged 65 years and older, higher cooking skills were not only associated with a higher frequency of home cooking, but also with healthier food choices, such as lower convenience food, processed food, and higher vegetable intake [12–15]. Cooking skill interventions targeting adults, including older adults, have shown that improving cooking skills increases confidence in cooking and cooking from basic ingredients [16, 17]. However, there is limited study on whether cooking skills are associated with health outcomes beyond diet.

Aging is probably one of the major factors that create situations where people have to prepare their own meals. Living alone, with no one to cook meals for them due to bereavement, divorce, or other family changes, can happen more frequently in aging, is one of the most prominent features of an ongoing aging society [18]. In Japan, 11% of older people aged 65 and older lived alone in 1980, increasing to 29% in 2019 [19]. Numerous studies have shown that living alone is associated with an increased risk of mortality [20–28]. This mortality risk was especially higher for those living alone due to divorce or bereavement [27, 28]. Older people who do not have someone to cook their meals were reported to be at higher risk of being underweight if they have poor cooking skills [15]. These results suggest that health risks to older adults due to poor cooking skills may be more pronounced among those living alone.

Therefore, this study aimed to investigate whether a cooking skill is associated with mortality according to cohabitation status in older Japanese people.

Methods

Study design and participants

Cohort data from the Japan Gerontological Evaluation Study (JAGES) conducted from 2016 to 2019 was used in this study. JAGES was established to assess the social determinants of healthy aging in Japan [29, 30]. Details of the study design are described elsewhere [31]. The baseline survey was conducted in 23 municipalities

across Japan in 2016, with self-reported questionnaires distributed by mail to 129,311 individuals aged 65 and older without functional disabilities who were not certified as eligible for long-term care insurance benefits [32]. Random sampling was used in the larger municipalities, while a complete census of older residents was conducted in the smaller municipalities. A total of 92,234 people returned the questionnaire (response rate: 71%), and 98% of respondents could be linked to information on deaths during the 3-year follow-up period (N=90,896). In this JAGES survey, one of the eight questionnaires was randomly assigned to each participant. Thus, one-eighth of the sample received the cooking skills questionnaire module (N=11,291). The sample for analysis consisted of 10,647 participants, excluding those missing data on the cooking skills questionnaire (N=500) and the cohabitation status (N=50) and those who reported receiving care and assistance with walking, bathing, and toileting in their daily lives (N=94). A flow chart of the participants is presented in Supplementary Fig. 1. Participants were informed that participation in the study was voluntary and that completion and return of the questionnaire constituted consent to participate in the study. The study was approved by the Ethics Committee on Research on Human Subjects at National Center for Geriatrics and Gerontology (No. 1274-2) and Chiba University (No. 3442).

Mortality status

Participants were linked to death records in the public long-term care insurance database to determine vital outcomes over a three-year follow-up period from 2016 to 2019 (mean:3.7 years, minimum: 3.1 years, maximum: 4.5 years). A total of 520 of the respondents died during the follow-up period (cumulative mortality=520/10,647, 4.9%).

Cooking skills

Cooking skills were assessed with a self-report baseline questionnaire using a cooking skills scale adapted for the Japanese based on the cooking skills scale for European cultural regions. (13) (15) The cooking skills scale consists of seven items designed to consider basic Japanese cooking methods—*Gohou* (five methods)—are raw food, boiling, grilling, steaming, and frying (33) and typical meals—known as *ichi-ju san-sai*—consists of a staple food (such as rice), a soup (usually miso), and three dishes (one main dish and two side dishes). (15, 34) The seven items are: (1) overall cooking skills, (2) able to peel vegetables and fruits, (3) able to boil eggs and vegetables, (4) able to grill fish, (5) able to make stir-fried meat and vegetables, (6) able to make miso soup, and (7) able to make stewed dishes. Responses were organized on a 6-point Likert scale ranging from not able (=1) to very

able (=6). The scale was found to have adequate internal consistency (Cronbach's $\alpha=0.96$) and remarkable discriminant validity, with women (experienced cooks) scoring significantly better than men (novice cooks) [15]. The mean scores of seven items were calculated and categorized as high or low based on the mean score, using a cut-off of >4.0 for high, according to the previous study [15].

Cohabitation status

Cohabitation statuses were assessed in a self-reported baseline questionnaire with the following question "What is your family structure?". Options were as follows: live alone, live with spouse only, live with the child, and live with others including three generations. Participants who selected "live alone" were categorized as living alone and those who selected other options were categorized as "living with others".

Covariates

Covariates were assessed using a self-report questionnaire at baseline (Table 1). As potential confounders which can be associated with both cooking skills and mortality, (15) socio-demographic characteristics (education, annual household income, employment status, and marital status), higher-level functional capacity, depressive symptoms, and availability of food stores were included. Education was categorized as low with 9 years or less of educational attainment, medium with 10–12 years, and high group with 13 years or more. Annual household income was adjusted for household size, dividing the income by the square root of the number of household people and divided into three groups (<2.00 , $2.00-4.00$, and ≥ 4.00 million yen). Employment status was divided into three groups (working, retired, and never worked). Marital status was divided into four groups (married, bereaved, divorced, and not married). Higher-level functional capacity was assessed using the Tokyo Metropolitan Institute of Gerontology Index of Competence and categorized as either fully capable (score=13) or less capable (score ≤ 12). (35) Depressive symptoms were assessed using the Geriatric Depression Scale (GDS) and categorized as either non-depressed (GDS <5) or depressed (GDS ≥ 5). (36) Availability of food stores was assessed by how many food stores selling fresh fruits and vegetables are located within a 1-kilometer radius of the residence. (37) Potential mediators included frequency of home cooking, frequency of eating outside the home, frequency of vegetable/fruit intake, body mass index (BMI), which are known to be associated with cooking skills. (15) Frequency of home cooking and eating outside the home were divided into five groups (more than five times a week, three to five times a week, one to two times a week, less than once a week, and never). (15) Frequency of vegetable/fruit intake was divided into two

groups (≥ 1 /day and <1 /day). (15) BMI was calculated as weight divided by the square of height (kg/m^2) and divided into three groups (<18.5 kg/m^2 , $18.5-22.9$ kg/m^2 , $23.0-27.4$ kg/m^2 , and ≥ 27.5 kg/m^2), following the suggested cutoff points for Asians (38). This cutoff value was also chosen because a BMI of 22.5 to 27.5 has the lowest risk of mortality among older people. (39) We included the frequency of going out (≥ 4 times/week, 2–3 times/week, 1 time/week, and ≤ 1 time/week) and time spent walking or standing (<1 h/day, 1–3 h/day, and ≥ 3 h/day) as a potential mediating factor because the main reason for going out among older adults in Japan is food shopping, (40, 41) and cooking requires standing. Covariates with missing data were categorized as "missing."

Statistical analysis

Cox proportional hazards models were estimated, yielding hazard ratios (HRs) and 95% confidence intervals (CIs) for all-cause mortality during the 3-year follow-up period. Analyses were stratified by cohabitation status and performed before and after propensity score matching. In the analysis before propensity score matching, the following sequence of models was constructed: Model 1 was crude; Model 2 was adjusted for age, sex, education, income, employment status, marital status, higher-level functional capacity, depressive symptoms, and availability of food stores as potential confounders.

In the propensity score analysis, individuals with high cooking skills were matched with individuals with low cooking skills on a 1:1 propensity score. The probability of high cooking skills versus low cooking skills was calculated by a multivariate logistic regression model that included all baseline covariates including age, sex, education, income, employment status, marital status, higher-level functional capacity, depressive symptoms, and availability of food stores. The estimated propensity score was used to match those with high cooking skills with those with low cooking skills using a caliper size of 0.01 on the propensity scale. Using the matched samples, we examined the association between cooking skills and mortality by cohabitation status based on a Cox proportional hazards model stratified for matched pairs.

The mediation analysis of the association between cooking skills and mortality was assessed by Difference method [42]. The magnitude of the mediating effects of frequency of home cooking, frequency of eating outside the home, frequency of vegetable/fruit intake, BMI, frequency of going out and time spent walking/standing were assessed separately according to the percentage change in HRs for cooking skills calculated as $\{[(\text{HR}_{\text{base model}}) - (\text{HR}_{\text{base model with mediator}})] / [(\text{HR}_{\text{base model}}) - 1]\} \times 100$ [43]. All analyses were conducted using Stata, Version 15.

Table 1 Characteristics of older Japanese adults from the JAGES cohort study according to cohabitation status (n = 10,647)

		Total		Cohabitation status	
		n	%	Live alone (n = 1,498)	Live with others (n = 9,149)
				%	%
Cooking skill					
	High	7993	75.1	87.5	73.0
	Low	2654	25.0	12.4	27.0
Sex					
	Men	4840	45.5	31.0	47.8
	Women	5807	54.5	69.0	52.2
Age (years)					
	65–69	3241	30.4	24.6	31.4
	70–74	2906	27.3	23.6	27.9
	75–79	2397	22.5	24.7	22.2
	≥ 80	2103	19.8	27.1	18.5
Education (years)					
	Low (≤ 9)	3602	33.8	39.4	32.9
	Middle (10–12)	4314	40.5	37.4	41.0
	High (≥ 13)	2583	24.3	21.9	24.6
	Other/Missing	148	1.4	1.3	1.4
Annual income (million yen)					
	Low (< 2.00)	4185	39.3	43.3	38.7
	Middle (2.00–3.99)	3356	31.5	22.5	33.0
	High (≥ 4.00)	899	8.4	4.5	9.1
	Missing	2207	20.7	29.8	19.2
Employment status					
	Working	2687	25.2	21.2	25.9
	Retired	5646	53.0	50.9	53.4
	Never worked	715	6.7	7.7	6.5
	Missing	1599	15.0	20.1	14.2
Marital status					
	Married	7702	72.3	3.7	83.6
	Bereaved	2065	19.4	61.7	12.5
	Divorced	388	3.6	16.7	1.5
	Not married	273	2.6	13.9	0.7
	Other/missing	219	2.1	4.0	1.7
Higher-level functional capacity					
	Fully capable	4003	37.6	36.2	37.8
	Less capable	5742	53.9	53.7	54.0
	Missing	902	8.5	10.1	8.2
Depressive symptoms					
	Non-depressed (GDS < 5)	7079	66.5	56.0	68.2
	Depressed (5 ≤ GDS)	1874	17.6	25.0	16.4
	Missing	1694	15.9	19.0	15.4
Food store availability					
	Highest	2998	28.6	25.3	29.1
	Middle-high	5244	50.0	54.0	49.4
	Middle-low	1503	14.3	13.2	14.5
	Lowest	707	6.7	7.0	6.7
	missing	36	0.3	0.6	0.3
Frequency of home cooking (n/week)					
	≥ 5	5440	51.1	68.7	48.2
	3–4	859	8.1	16.2	6.7
	1–2	728	6.8	6.4	6.9
	< 1	726	6.8	2.5	7.5

Table 1 (continued)

	Total		Cohabitation status	
	n	%	Live alone (n = 1,498) %	Live with others (n = 9,149) %
Never	2772	26.0	4.7	29.5
Missing	122	1.1	1.5	1.1
Frequency of eating outside the home (n/week)				
≥ 5	190	1.8	3.3	1.5
3–4	380	3.6	5.7	3.2
1–2	1419	13.3	16.1	12.9
< 1	4278	40.2	35.6	40.9
Never	4138	38.9	36.8	39.2
Missing	242	2.3	2.4	2.3
Frequency of vegetable/fruit intake (n/day)				
≥ 1	8402	78.9	70.8	80.2
< 1	2106	19.8	27.8	18.5
Missing	139	1.3	1.3	1.3
Body weight status (BMI, kg/m ²)				
Underweight (< 18.5)	724	6.8	8.7	6.5
Normal (18.5–22.9)	4922	46.2	48.9	45.8
Overweight (23.0–27.4)	3915	36.8	31	37.7
Obesity (≥ 27.5)	788	7.4	7.7	7.4
Missing	298	2.8	3.7	2.7
Frequency of going out (n/week)				
≥ 4	7805	73.3	69.5	73.9
2–3	1974	18.5	21.9	18.0
1	367	3.4	3.8	3.4
< 1	394	3.7	3.9	3.7
Missing	107	1.0	0.9	1.0
Time spent walking or standing (hour/day)				
< 1	1348	12.7	13.8	12.5
1–2	4046	38.0	42.1	37.3
≥ 3	5070	47.6	41.8	48.6
Missing	183	1.7	2.3	1.6

BMI=body mass index; GDS=geriatric Depression Scale

Results

Among the participants from the JAGES cohort study, half were female, one-fifth were over 80 years old, one-third had less than 9 years of educational attainment, 40% had an annual income of less than 2 million yen, and more than half were retired (Table 1). A quarter of the participants were categorized as having low cooking skills. Overall, 14% lived alone and 86% lived with others. Participants who lived alone tended to be female, older, of lower socioeconomic status, bereaved or divorced, and more depressed than those who lived with others. Those who live alone cook at home more often than those who live with others, but many also eat out and consume vegetables/fruit less frequently. Those living alone tended to go out less often and spend less time walking/standing.

Propensity score matching resulted in 171 matched pairs for those living alone and 2,161 matched pairs for those living with others. Characteristics of participants before and after propensity-score matching for each are

shown in Table 2 (living alone) and Table 3 (living with others). In both cohabitation statuses, most covariates were biased by the level of cooking skill before propensity score matching. After propensity score matching, these biases were reduced and there were no longer statistically significant differences by level of cooking skills for most covariates.

The association between cooking skills and mortality before and after propensity score matching was shown in Table 4. During the follow-up period, 87 (5.8%) of those living alone and 433 (4.7%) of those living with others died. Among those living alone, the incidence rate of mortality was 3.42 (95% CI: 2.65–4.41) per 100,000 person-years for those with high cooking skills and 11.8 (95% CI: 8.15–17.1) for those with low cooking skills. Among those living with others, the incidence rate of mortality was 2.82 (95% CI: 2.49–3.20) per 100,000 person-years for those with high cooking skills and 5.88 (95% CI: 5.09–6.79) for those with low cooking skills. For

Table 2 Characteristics of older Japanese adults who lived alone from the JAGES cohort study according to the cooking skill before and after propensity-score matching

		Before Matching				After Matching			
		Cooking skill		%Bias	p-value ^a	Cooking skill		%Bias	p-value ^a
		High	Low			High	Low		
		n = 1,311	n = 187	n = 171	n = 171				
		%	%	%	%				
Sex									
	Men	25.5	69.5	reference	< 0.001	72.5	66.7	reference	0.24
	Women	74.5	30.5	98.1		27.5	33.3	-13.0	
Age (years)									
	65–69	23.5	25.7	reference	0.34	29.8	28.1	reference	0.84
	70–74	23.6	23.5	0.1		21.6	24.6	-6.9	
	75–79	25.4	19.8	13.4		22.8	19.9	7.0	
	≥ 80	26.5	31.0	-9.9		25.7	27.5	-3.9	
Education (years)									
	Low (≤ 9)	40.3	33.2	reference	0.06	34.5	34.5	reference	0.92
	Middle (10–12)	36.5	43.9	-15.1		43.3	41.5	3.6	
	High (≥ 13)	21.7	23.0	-3.0		22.2	24.0	-4.2	
	Other/Missing	1.5	0.0	17.6		0.0	0.0	0	
Annual income (million yen)									
	Low (< 2.00)	44.3	35.8	reference	0.10	33.9	37.4	reference	0.32
	Middle (2.00–3.99)	21.7	27.8	-14.1		33.3	26.9	14.9	
	High (≥ 4.00)	4.6	3.7	4.2		1.2	3.5	-11.7	
	Missing	29.4	32.6	-7.0		31.6	32.2	-1.3	
Employment status									
	Working	21.1	22.5	reference	0.33	23.4	24.0	reference	0.99
	Retired	50.4	54.5	-8.3		56.1	54.4	3.5	
	Never worked	8.2	4.8	13.6		4.1	4.7	-2.4	
	Missing	20.4	18.2	5.5		16.4	17.0	-1.5	
Marital status									
	Married	3.4	6.4	reference	< 0.001	7.0	6.4	reference	0.99
	Bereaved	63.8	46.5	35.3		46.8	46.2	1.2	
	Divorced	15.8	23.0	-18.3		20.5	22.2	-4.4	
	Not married	13.3	18.2	-13.5		20.5	19.3	3.2	
	Other/missing	3.7	5.9	-10.0		5.3	5.8	-2.7	
Instrumental activities of daily living (IADL)									
	Fully capable	38.8	17.6	reference	< 0.001	21.1	19.3	reference	0.92
	Less capable	51.4	69.5	-37.6		67.3	69.0	-3.6	
	Missing	9.8	12.8	-9.7		11.7	11.7	0	
Depressive symptoms									
	Non-depressed (GDS < 5)	58.1	41.2	reference	< 0.001	42.7	43.9	reference	0.87
	Depressed (5 ≤ GDS)	23.0	38.5	-33.9		35.1	36.3	-2.6	
	Missing	18.8	20.3	-3.7		22.2	19.9	5.9	
Food store availability									
	Highest	25.9	17.6	reference	0.06	17.5	18.7	reference	0.61
	Middle-high	51.7	62.6	-22.0		56.1	60.8	-9.5	
	Middle-low	13.0	12.3	2.2		15.2	13.5	5.3	
	Lowest	7.1	5.3	7.2		8.8	4.7	16.9	
	Missing	2.3	2.1	1.0		2.3	2.3	0	

^a Chi-squared test was done for examining statistical significance

Table 3 Characteristics of older Japanese adults who lived with others from the JAGES cohort study according to the cooking skill before and after propensity-score matching

		Before Matching				After Matching			
		Cooking skill		%Bias	p-value ^a	Cooking skill		%Bias	p-value ^a
		High	Low			High	Low		
		n = 6,682	n = 2,467	n = 2,161	n = 2,161				
%	%	%	%						
Sex									
	Men	32.9	88.3	reference	< 0.001	86.9	86.8	reference	0.96
	Women	67.1	11.7	137.8		13.1	13.2	-0.1	
Age (years)									
	65–69	32.9	27.4	reference	< 0.001	28.7	29.1	reference	0.21
	70–74	28.2	27.2	2		28.0	28.4	-0.7	
	75–79	22.5	21.3	2.9		20.2	21.9	-4.1	
	≥ 80	16.5	24.1	-19		23.0	20.6	6.1	
Education (years)									
	Low (≤ 9)	33.1	32.5	reference	0.001	30.7	31.5	reference	0.65
	Middle (10–12)	41.9	38.8	6.4		39.9	39.7	0.4	
	High (≥ 13)	23.6	27.5	-9		27.9	27.7	0.4	
	Other/Missing	1.5	1.2	2.2		1.5	1.1	3.6	
Annual income (million yen)									
	Low (< 2.00)	37.8	40.9	reference	0.001	39.5	41.1	reference	0.12
	Middle (2.00–3.99)	32.8	33.4	-1.2		32.2	33.7	-3.2	
	High (≥ 4.00)	9.1	9.1	-0.1		10.6	9.2	5.1	
	Missing	20.2	16.5	9.6		17.7	16.0	4.4	
Employment status									
	Working	24.8	28.8	reference	< 0.001	32.1	30.0	reference	0.06
	Retired	52.2	56.5	-8.6		52.1	56.0	-7.9	
	Never worked	7.7	3.5	18.3		4.3	3.5	3.4	
	Missing	15.3	11.2	12		11.5	10.5	3.1	
Marital status									
	Married	81.2	89.9	reference	< 0.001	86.1	89.6	reference	0.01
	Bereaved	14.4	7.3	23.1		10.1	7.5	8.5	
	Divorced	1.8	0.6	10.7		1.0	0.7	2.5	
	Not married	0.7	0.7	-0.3		0.8	0.7	1.6	
	Other/missing	1.8	1.5	2.5		2.0	1.5	3.6	
Instrumental activities of daily living (IADL)									
	Fully capable	42.4	25.4	reference	< 0.001	27.6	28.4	reference	0.05
	Less capable	49.1	67.1	-37.1		62.6	63.9	-2.8	
	Missing	8.5	7.5	3.5		9.8	7.7	7.7	
Depressive symptoms									
	Non-depressed (GDS < 5)	69.1	65.8	reference	< 0.001	67.0	69.6	reference	0.18
	Depressed (5 ≤ GDS)	14.7	21.0	-16.4		19.1	17.5	4.2	
	Missing	16.2	13.2	8.5		13.9	12.9	2.9	
Food store availability									
	Highest	30.1	24.9	reference	< 0.001	26.1	26.7	reference	0.85
	Middle-high	47.8	50.8	-6.00		49.8	50.3	-1.1	
	Middle-low	14.2	14.6	-1.3		14.6	14.3	1.1	
	Lowest	6.2	7.6	-5.5		7.5	7.0	1.6	
	Missing	1.7	2.0	-2.7		2.0	1.6	2.8	

^a Chi-squared test was done for examining statistical significance

Table 4 Hazard ratios (HR) with 95% CI for the association of mortality with cooking skills according to cohabitation status in older Japanese adults from the JAGES cohort study before and after propensity-score matching

Cohabitation status	Cooking skill	Before matching			After matching ^a			
		N	Number of death (%)	Incidence rate per 100,000 person-years (95% CI)	Model 1 HR (95%CI)	Model 2 HR (95%CI)	N	HR (95%CI)
Living alone	High	1311	59 (4.5)	3.42 (2.65–4.41)	ref	ref	171	ref
	Low	187	28 (15.0)	11.8 (8.15–17.1)	3.50 (2.23–5.49)	2.19 (1.32–3.65)	171	2.50 (1.10–5.68)
Living with others	High	6,682	247 (3.7)	2.82 (2.49–3.20)	ref	ref	2,161	ref
	Low	2,467	186 (7.5)	5.88 (5.09–6.79)	2.09 (1.73–2.53)	1.12 (0.91–1.38)	2,161	1.05 (0.82–1.33)

HR=hazard ratio; CI=confidence interval; ref=reference group

The boldface indicates statistical significance ($p < 0.05$)

Model 1: Crude

Model 2: Adjusted for age, sex, education, annual income, employment status, marital status, higher-level functional capacity, depressive symptoms, and food store availability

^aIndividuals with high cooking skills were matched with individuals with low cooking skills on a 1:1 propensity score using a caliper size of 0.01. The propensity score was calculated by a multivariate logistic regression model that included age, sex, education, annual income, employment status, marital status, higher-level functional capacity, depressive symptoms, and food store availability**Table 5** The magnitude of the mediating effect of potential mediators on the association of mortality with cooking skills among older Japanese adults living alone from the JAGES cohort study ($n = 1,498$)

Model	Cooking skills	HR (95%CI)	Percent-age of mediating effect ^b
Base model ^a	High	ref	
	Low	2.19 (1.32–3.65)	
Base model + frequency of home cooking	High	ref	
	Low	2.02 (1.17–3.48)	14.7
Base model + frequency of vegetable/fruit intake	High	ref	
	Low	2.12 (1.27–3.52)	6.6
Base model + frequency of going out	High	ref	
	Low	2.02 (1.21–3.37)	14.3
Base model + time spent walking/standing	High	ref	
	Low	2.10 (1.26–3.51)	7.6
Base model + all mediators ^c	High	ref	
	Low	1.88 (1.08–3.27)	26.1

h=hazard ratio; CI=confidence interval; ref=reference group

Boldface indicates statistical significance ($p < 0.05$)^a Model 2 in Table 4^b $\frac{[(HR \text{ base model}) - (HR \text{ base model with mediator})]}{[(HR \text{ base model}) - 1]} \times 100$ ^c Mediators included frequency of home cooking, frequency of vegetable/fruit intake, frequency of going out, and time spent walking/standing

those living alone, the HR for low (vs. high) cooking skills was 3.50 (95% CI: 2.23–5.49) in the crude model before propensity score matching and remained significant after adjustment for potential confounders (HR=2.19, 95%

CI: 1.32–3.65). After propensity score matching, the HR of low cooking skills was 2.50 (95% CI: 1.10–5.68) with a significantly higher risk of death. For those living with others, the HR for low (vs. high) cooking skills was 2.09 (95% CI: 1.73–2.53) in the crude model before propensity score matching, but was non-significant when adjusted for potential confounders (HR=1.12, 95% CI: 0.91–1.38). The results of propensity score matching were similar, with cooking skills not significantly associated with mortality risk (HR=1.05, 95% CI: 0.82–1.33).

In the analysis of the mediation effect, the frequency of home cooking and the frequency of going out showed relatively high mediation effects (Table 5). The proportion of mediation effect was 14.7% for the frequency of home cooking, 6.6% for the frequency of vegetable/fruit intake, 14.3% for the frequency of going out, and 7.6% for time spent walking/standing. 26.1% for all four mediators. These four factors mediated about a quarter of the association between cooking skills and mortality. No mediating effects were found for the frequency of going outside the home and BMI.

Discussion

Lower cooking skills were associated with higher mortality risk only for those living alone. Considering that the aging society has increased the prevalence of living alone, this study would be of public health value in showing the importance of cooking skills among older adults.

To the best of our knowledge, this is the first study to examine the association between cooking skills and mortality. The associations differ by cohabitation status, that is, the increased risk of mortality due to lower cooking skills was found only for those living alone, which is not true for older people living with cohabitants. This result may partially explain the association between living alone

and mortality risk. Living alone is known to be a robust mortality risk, [20–28] sometimes reported to be higher risk in bereavement, divorce, and men [21, 22, 27, 28]. These high-risk individuals are expected to have little opportunities to cook and poor cooking skills by the time they are living alone. Therefore, cooking skills may mediate the association between living alone and death.

The association between cooking skills and mortality was partially mediated by the frequency of home cooking, vegetable/fruit intake, going out, and time spent walking/standing (Table 5, Supplementary Fig. 2). We have confirmed that lower cooking skills were associated with a lower frequency of going out and shorter walking/standing times in this sample. A nationally representative survey in Japan reported that the majority of older adults chose ‘shopping’ as their main reason for going out, [40] and 60% of older adults responsible for food shopping go shopping at least three times a week [41]. Considering that cooking is a household chore performed standing, cooking skills may be associated with mortality via physical activity such as frequency of going out and standing time. Further, cooking behavior per se may be protective against mortality by providing opportunities for cognitive stimulus, such as thinking about the menu, and going out shopping may be good for physical activity and meeting with acquaintances.

Cooking skills were not associated with death among those living with others. In the cohabitants, most of the subjects after propensity score matching were male. As women are mainly in charge of preparing meals in Japan, [15] the spouse was primarily responsible for meal preparation, and his level of cooking skill may not have affected the quality of the meal.

The study had several limitations. First, we did not assess the quality of the meals they prepared, and the respondents cooking behaviors. Therefore, it is possible that people preparing lower-quality meals were included in groups with higher cooking skills, in which case the results were underestimated. However, we confirmed that low cooking skills, as measured using the cooking skill scale, were associated with low fruit and vegetable intake and being underweight among older adults [15]. Second, changes in cohabitation status during the follow-up period could not be considered. As those living alone increase with age, it is possible that some cohabitants changed to living alone during the follow-up period, in which case cohabitant results may have been overestimated. Third, the generalizability of the findings to other populations is limited because cooking methods and foods vary from culture to culture. Fourth, the follow-up period is relatively short. However, since many people learn cooking skills at a young age, [44] the likelihood of reverse causation would be low. Fifth, the difference method we used for our mediation analysis

cannot account for confounding factors of the mediating variables. Further detailed mediation analysis will be necessary to elucidate the mechanism of the association between cooking skills and mortality. Finally, because we were only able to assess all-cause mortality, we will need to examine the causes of death to understand mechanisms.

Conclusion

We confirmed that lower cooking skills were associated with a higher risk of mortality and that this association differed by cohabitation status. The benefit of cooking skills was to the single residents. In other words, older adults with high cooking skills do not have an increased risk of death even if they live alone. Frequency of home cooking, vegetable/fruit intake, and physical activity, including going out and time spent walking/standing, partially mediated the association between cooking skills and mortality. Considering that prevalence of living alone increases with age, research on support for improving the cooking skills of older adults is needed.

Abbreviations

BMI	body mass index
CI	confidence interval
JAGES	Japan Gerontological Evaluation Study
GDS	Geriatric Depression Scale
HRs	hazard ratios

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12966-023-01522-1>.

Supplementary Material 1

Acknowledgements

We are particularly grateful to the staff members in each study area and in the central office for conducting the survey.

Authors' contributions

YT conceived the design, analyzed the data, reviewed literature and wrote first draft of paper. KK collected data. TF revised the first draft. TA, KK edited the manuscript. All authors approved the final version of the manuscript.

Funding

This study used data from JAGES (the Japan Gerontological Evaluation Study). This study was supported by JSPS (Japan Society for the Promotion of Science) KAKENHI Grant Number (JP15H01972, 22K10578), Health Labour Sciences Research Grant (H28-Choju-Ippan-002), Japan Agency for Medical Research and Development (AMED) (JP18dk0110027, JP18ls0110002, JP18le0110009, JP20dk0110034, JP21lk0310073, JP21dk0110037, JP22lk0310087), Open Innovation Platform with Enterprises, Research Institute and Academia (OPERA, JPMJOP1831), a grant from Innovative Research Program on Suicide Countermeasures [1–4], a grant from Sasakawa Sports Foundation, a grant from Japan Health Promotion & Fitness Foundation, a grant from Chiba Foundation for Health Promotion & Disease Prevention, the 8020 Research Grant for fiscal 2019 from the 8020 Promotion Foundation (adopted number: 19-2-06), grants from Meiji Yasuda Life Foundation of Health and Welfare and the Research Funding for Longevity Sciences from National Center for Geriatrics and Gerontology (29–42, 30–22, 20–19, 21–20). This study was also supported by a grant-in-aid from the Ministry of Health, Labor, and

Welfare (22FA2001, 22FA1010). The funders had no role in designing the study and have not been involved in conducting the research.

Data Availability

The datasets used and analysed during the current study are from the JAGES study. All enquiries are to be addressed at the data management committee via e-mail: dataadmin.ml@jages.net. All JAGES datasets have ethical or legal restrictions for public deposition due to inclusion of sensitive information from the human participants.

Declarations

Ethics approval and consent to participants

We described in [Methods](#) section as follows: Participants were informed that participation in the study was voluntary and that completion and return of the questionnaire constituted consent to participate in the study. The study was approved by the Ethics Committee on Research on Human Subjects at National Center for Geriatrics and Gerontology (No. 1274-2) and Chiba University (No. 3442).

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Received: 16 March 2023 / Accepted: 26 September 2023

Published online: 10 November 2023

References

- Smith LP, Ng SW, Popkin BM. Trends in US home food preparation and consumption: analysis of national nutrition surveys and time use studies from 1965–1966 to 2007–2008. *Nutr J*. 2013;12:45.
- Moser A. Food preparation patterns in German family households. An econometric approach with time budget data. *Appetite*. 2010;55(1):99–107.
- Nielsen SJ, Siega-Riz AM, Popkin BM. Trends in food locations and sources among adolescents and young adults. *Prev Med*. 2002;35(2):107–13.
- Mills S, White M, Brown H, Wrieden W, Kwasnicka D, Halligan J, et al. Health and social determinants and outcomes of home cooking: a systematic review of observational studies. *Appetite*. 2017;111:116–34.
- Wolfson JA, Leung CW, Richardson CR. More frequent cooking at home is associated with higher healthy eating Index-2015 score. *Public Health Nutr*. 2020;23(13):2384–94.
- Lichtenstein AH, Ludwig DS. Bring back home economics education. *JAMA*. 2010;303(18):1857–8.
- Bennett G, Young E, Butler I, Coe S. The impact of Lockdown during the COVID-19 outbreak on Dietary Habits in various Population Groups: a scoping review. *Front Nutr*. 2021;8:626432.
- Flanagan EW, Beyl RA, Fearnbach SN, Altazan AD, Martin CK, Redman LM. The impact of COVID-19 Stay-At-Home orders on Health Behaviors in adults. *Obes (Silver Spring)*. 2021;29(2):438–45.
- Monteiro CA, Moubarac JC, Cannon G, Ng SW, Popkin B. Ultra-processed products are becoming dominant in the global food system. *Obes Rev*. 2013;14(Suppl 2):21–8.
- Chen X, Zhang Z, Yang H, Qiu P, Wang H, Wang F, et al. Consumption of ultra-processed foods and health outcomes: a systematic review of epidemiological studies. *Nutr J*. 2020;19(1):86.
- Lavelle F, McGowan L, Spence M, Caraher M, Raats MM, Hollywood L, et al. Barriers and facilitators to cooking from 'scratch' using basic or raw ingredients: a qualitative interview study. *Appetite*. 2016;107:383–91.
- van der Horst K, Brunner TA, Siegrist M. Ready-meal consumption: associations with weight status and cooking skills. *Public Health Nutr*. 2011;14(2):239–45.
- Hartmann C, Dohle S, Siegrist M. Importance of cooking skills for balanced food choices. *Appetite*. 2013;65:125–31.
- Lam MCL, Adams J. Association between home food preparation skills and behaviour, and consumption of ultra-processed foods: cross-sectional analysis of the UK National Diet and nutrition survey (2008–2009). *Int J Behav Nutr Phys Act*. 2017;14(1):68.
- Tani Y, Fujiwara T, Kondo K. Cooking skills related to potential benefits for dietary behaviors and weight status among older Japanese men and women: a cross-sectional study from the JAGES. *Int J Behav Nutr Phys Act*. 2020;17(1):82.
- Flego A, Herbert J, Waters E, Gibbs L, Swinburn B, Reynolds J, et al. Jamie's Ministry of Food: quasi-experimental evaluation of immediate and sustained impacts of a cooking skills program in Australia. *PLoS ONE*. 2014;9(12):e114673.
- Reicks M, Kocher M, Reeder J. Impact of Cooking and Home Food Preparation Interventions among adults: a systematic review (2011–2016). *J Nutr Educ Behav*. 2018;50(2):148–72e1.
- Reher D, Requena M. Living alone in later life: A Global Perspective. *Popul Dev Rev*. 2018;44(3):427–54.
- Cabinet Office. White papers from FY2020. Tokyo; 2021. (in Japanese).
- Gopinath B, Rohtchina E, Anstey KJ, Mitchell P. Living alone and risk of mortality in older, community-dwelling adults. *JAMA Intern Med*. 2013;173(4):320–1.
- Kandler U, Meisinger C, Baumert J, Löwel H. Living alone is a risk factor for mortality in men but not women from the general population: a prospective cohort study. *BMC Public Health*. 2007;7:335.
- Pimouguet C, Rizzuto D, Schön P, Shakersain B, Angleman S, Lagergren M, et al. Impact of living alone on institutionalization and mortality: a population-based longitudinal study. *Eur J Public Health*. 2016;26(1):182–7.
- Ng N, Santosa A, Weinehall L, Malmberg G. Living alone and mortality among older people in Västerbotten County in Sweden: a survey and register-based longitudinal study. *BMC Geriatr*. 2020;20(1):7.
- Jensen MT, Marott JL, Holtermann A, Gyntelberg F. Living alone is associated with all-cause and cardiovascular mortality: 32 years of follow-up in the Copenhagen Male Study. *Eur Heart J Qual Care Clin Outcomes*. 2019;5(3):208–17.
- Tabue Teguo M, Simo-Tabue N, Stoykova R, Meillon C, Cogne M, Amiéva H, et al. Feelings of loneliness and living alone as predictors of mortality in the Elderly: the PAQUID Study. *Psychosom Med*. 2016;78(8):904–9.
- Shaw BA, Dahlberg L, Nilsen C, Agahi N. Trends in the mortality risk of living alone during old age in Sweden, 1992–2011. *J Aging Health*. 2020;32(10):1399–408.
- Ng TP, Jin A, Feng L, Nyunt MS, Chow KY, Feng L, et al. Mortality of older persons living alone: Singapore Longitudinal Ageing Studies. *BMC Geriatr*. 2015;15:126.
- Abell JG, Steptoe A. Why is living alone in older age related to increased mortality risk? A longitudinal cohort study. *Age Ageing*. 2021;50(6):2019–24.
- Kondo K, Rosenberg M, World Health Organization. Advancing universal health coverage through knowledge translation for healthy ageing: lessons learnt from the Japan gerontological evaluation study. *World Health Organization*; 2018.
- Kondo K. Progress in Aging Epidemiology in Japan: the JAGES Project. *J Epidemiol*. 2016;26(7):331–6.
- Watanabe R, Tsuji T, Ide K, Noguchi T, Yasuoka M, Kamiji K, et al. Predictive validity of the modified Kihon Checklist for the incidence of functional disability among older people: a 3-year cohort study from the JAGES. *Geriatr Gerontol Int*. 2022;22(8):667–74.
- Tamiya N, Noguchi H, Nishi A, Reich MR, Ikegami N, Hashimoto H, et al. Population ageing and wellbeing: lessons from Japan's long-term care insurance policy. *Lancet*. 2011;378(9797):1183–92.
- Higashi A. WASYOKU and Health. *Chem Educ*. 2015;63:38–9. (in Japanese).
- Ministry of Agriculture Forestry and Fisheries. WASHOKU: Ministry of Agriculture, Forestry and Fisheries; [Available from: http://www.maff.go.jp/j/keikaku/syokubunka/culture/pdf/guide_all.pdf]. (in Japanese).
- Koyano W, Shibata H, Nakazato K, Haga H, Suyama Y. Measurement of competence: reliability and validity of the TMIG Index of competence. *Arch Gerontol Geriatr*. 1991;13(2):103–16.
- Wada T, Ishine M, Kita T, Fujisawa M, Matsubayashi K. Depression screening of elderly community-dwelling Japanese. *J Am Geriatr Soc*. 2003;51(9):1328–9.
- Tani Y, Suzuki N, Fujiwara T, Hanazato M, Kondo N, Miyaguni Y, et al. Neighborhood food environment and mortality among older Japanese adults: results from the JAGES cohort study. *Int J Behav Nutr Phys Act*. 2018;15(1):101.
- WHO Expert Consultation. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. *Lancet*. 2004;363(9403):157–63.

39. Global BMIM, Di Collaboration E, Bhupathiraju Sh N, Wormser D, Gao P, Kaptoke S, et al. Body-mass index and all-cause mortality: individual-participant-data meta-analysis of 239 prospective studies in four continents. *Lancet*. 2016;388(10046):776–86.
40. Director General for Policy on Cohesive Society Cabinet Office, Government of Japan. Results of Survey on the Senior Citizen's Attitude Toward Housing and the Living Environment for FY 2010. Tokyo, Japan.; 2011. [Available from: www8.cao.go.jp/kourei/ishiki/h22/sougou/zentai/index.html in Japanese].
41. National Health and Nutrition Survey. Results of the National Health and Nutrition Survey Japan., 2011 Tokyo: Ministry of Health, Labor and Welfare; 2013 [Available from: <http://www.mhlw.go.jp/bunya/kenkou/eiyoudl/h23-houkoku-06.pdf>]. [in Japanese].
42. Jiang Z, VanderWeele TJ. When is the difference method conservative for assessing mediation? *Am J Epidemiol*. 2015;182(2):105–8.
43. Otsuka T, Tomata Y, Zhang S, Sugiyama K, Tanji F, Sugawara Y, et al. Association between social participation and incident risk of functional disability in elderly Japanese: the Ohsaki Cohort 2006. *J Psychosom Res*. 2018;111:36–41.
44. Lavelle F, Spence M, Hollywood L, McGowan L, Surgenor D, McCloat A, et al. Learning cooking skills at different ages: a cross-sectional study. *Int J Behav Nutr Phys Act*. 2016;13(1):119.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.