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Prevalence of Inadequate Nutrient Intake in Japanese Community-Dwelling Older Adults Who Live Alone

Miho NOZUE[1], Midori ISHIKAWA[2], Yukari TAKEMI[3], Kaoru KUSAMA[4], Yoshiharu FUKUDA[5], Tetsuji YOKOYAMA[2], Tomoki NAKAYA[6], Nobuo NISHI[1], Kaori YOSHIBA[7] and Nobuko MURAYAMA[8]

[1] *National Institute of Health and Nutrition, National institutes of Biomedical Innovation, Health and Nutrition, 1–23–1 Toyama, Shinjuku-ku, Tokyo 162–8636, Japan*
[2] *National Institute of Public Health, 2–3–6 Minami, Wako, Saitama 351–0197, Japan*
[3] *Kagawa Nutrition University, 3–9–21 Chiyoda, Sakado, Saitama 350–0288, Japan*
[4] *Aomori University of Health and Welfare, 58–1 Mase, Hamadate, Aomori 030–8505, Japan*
[5] *Graduate School of Public Health, Teikyo University, 2–11–1 Kaga, Itabashi-ku, Tokyo 173–8605, Japan*
[6] *Ritsumeikan University, 56–1 Tojiin Kitamachi, Kita-ku, Kyoto 603–8577, Japan*
[7] *Japan Association for Development of Community Medicine, Kaiun Bldg. 4F, 2–6–4 Hirakawa, Chiyoda-ku, Tokyo 102–0093, Japan*
[8] *University of Niigata Prefecture, 471 Ebigase, Higashi-ku, Niigata 950–8680, Japan*

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Summary Dietary assessment of community-dwelling Japanese older adults who live alone using Dietary Reference Intakes (DRIs) is limited. The present study aimed to estimate the prevalence of inadequate nutrient intake among Japanese community-dwelling older adults by sex and young-old and old-old population groups to identify the most vulnerable groups that need support. A cross-sectional survey was conducted from October 2012 to October 2013 with community-dwelling adults aged 65 y or older who lived alone. Participants were drawn from six cities in four Japanese prefectures. We used two days of dietary survey data to estimate participants' usual intake. The proportion of inadequate intake was assessed using the Estimated Average Requirement (EAR) cut-point method, Tolerable Upper Intake Level, and the tentative dietary goal for preventing life-style related diseases (DG) based on DRIs for Japanese, 2015. Data for 494 participants (162 male, 332 female) over 988 d were examined to assess nutrient intake. We calculated the proportion of inadequate intake between males and females and between young-old and old-old population groups (65–74 y and ≥75 y) using chi-square or Fisher's exact tests. For six nutrients, the estimated proportion of participants with a usual intake below EAR was higher in males than females. In addition, a higher estimated proportion of female participants was within the DG range for the percentage of energy from protein, fat, and carbohydrates, and had a usual intake of two nutrients above DG than males. Our findings showed that among Japanese older adults, males were more vulnerable in terms of inadequate nutrient intake compared with females.

Key Words Dietary Reference Intakes for Japanese (2015), dietary assessment, nutrient intake, older adults

The World Health Organization estimated that 524 million people were aged 65 y or older in 2010; equivalent to 8% of the world's population, and expected to represent 16% of the world's population by 2050 (*1*). In Japan, 25.1% of the total population was aged 65 y or older in 2013 (*2*). In 2012, the average life expectancy for males in Japan was 79.9 y and 86.4 y for females; the difference between life expectancy and healthy life expectancy was 9 y for males and more than 10 y for females (*3*). Therefore, one of the health policies of Health Japan 21 (the second term) is directed to extending the healthy life expectancy between 2013 and 2022 (*4*). Of all households with people aged 65 y or older in 2013, 25.6% of those aged 65 y or older lived alone (*5*). Currently, there is no unified opinion about older adults who live alone having a lower dietary intake compared with those who live with someone else (*6–10*).

Malnutrition is associated with a decline in functional status, immune dysfunction, and similar problems; improving dietary intake improves health and quality of life, and reduces mortality (*11–13*).

Several studies have been conducted on nutrient and food intake in older adults (*6*, *7*, *9*, *10*). However dietary assessments conducted using Dietary Reference Intakes (DRIs) are limited (*8*, *14*, *15*), and data on dietary assessment of Japanese older adults is particularly scarce (*16*, *17*). The National Health and Nutrition Survey in Japan included people aged 65 y and older, but only included a 1-d dietary survey (*18*), and therefore cannot estimate usual intake or be used to assess DRI nutrient intake

E-mail: mnozue@nih.go.jp

Table 1. Cut-off points for nutrients according to 2015 Dietary Reference Intakes.

		Male		Female	
		65–69	≥70	65–69	≥70
EAR					
Protein	g	50	50	40	40
Vitamin A	μgRAE	600	550	500	450
Vitamin B_1	mg	1.1	1	0.9	0.8
Vitamin B_2	mg	1.2	1.1	1	0.9
Niacin	mgNE	12	11	9	8
Vitamin B_6	mg	1.2	1.2	1	1
Vitamin B_{12}	μg	2	2	2	2
Folate	μg	200	200	200	200
Vitamin C	mg	85	85	85	85
Sodium	mg	600	600	600	600
Calcium	mg	600	600	550	550
Magnesium	mg	290	270	240	220
Iron	mg	6	6	5.5	5
Copper	mg	0.7	0.7	0.6	0.6
UL					
Vitamin A	μgRAE	2,700	2,700	2,700	2,700
Vitamin E	mg	850	750	700	650
Naicin	mgNE	350	300	250	250
Vitamin B_6	mg	55	50	45	40
Folate	μg	1,000	900	1,000	900
Calcium	mg	2,500	2,500	2,500	2,500
Phosphrous	mg	3,000	3,000	3,000	3,000
Iron	mg	50	50	40	40
Copper	mg	10	10	10	10
DG					
Protein	%energy	13–20	13–20	13–20	13–20
Fat	%energy	20–30	20–30	20–30	20–30
Carbohydrates	%energy	50–65	50–65	50–65	50–65
Dietary fiber	g	>20	>19	>18	>17
Salt	g	<8	<8	<7	<7
Potassium	mg	>3,000	>3,000	>2,600	>2,600

EAR (Estimated Average Requirment), UL (Tolerable Upper Intake Level), DG (Tentative Dietary Goal for Preventing Life-style Related Diseases).

considering within-individual variability.

The present study aimed to estimate the prevalence of inadequate nutrient intake among Japanese community-dwelling older adults who lived alone by sex and young-old and old-old population groups to identify those most vulnerable and needing support.

MATERIALS AND METHODS

Participants and study design. We conducted a cross-sectional survey in six towns/cities across four prefectures: Hokkaido (one town), Aomori (one town), Saitama (one town and one city), and Niigata (one town and one city) in Japan from October 2012 to October 2013. The study was reviewed and approved by the Ethics Committee of the Faculty of Medicine at the National Institute of Public Health, Wako, Saitama, Japan (NIPH-IBRA#12015, July 26th, 2012) in accord with the Helsinki Declaration. Research agreements were made with the mayors of the towns or cities. Residents aged 65 y or older who lived alone were extracted from the basic resident registers. Letters explaining the study protocol were posted to the identified older adults, along with self-administered questionnaires that included a question covering willingness to participate in the dietary survey. If a participant returned the questionnaire and indicated agreement to participate in the dietary survey, an investigator visited the participant's home and conducted the dietary survey.

Dietary survey. Dietary records for two nonconsecutive days were obtained from each participant. Each participant received two recording papers and an explanation about how to record the information. Participants were asked to write down the name of each dish, the ingredients, and the amount that they ate.

Nutrition analysis software Excel Eiyoukun version 6.0 (*19*) was used to calculate energy and nutrients, using the 2010 Standard Tables of Food Composition in Japan (*20*). Fortified nutrients were not considered in the calculation of nutrients.

During the dietary survey, participants' heights were

Table 2. Characteristics of study participants.

	Male n=162				Female n=332			
	mean	SD	minimum	maximum	mean	SD	minimum	maximum
Age	73.7	6.3	65.0	88.0	75.3	6.3	65.0	90.0
Height	162.9	6.7	139.1	178.2	149.5	5.9	130.0	164.0
Weight	63.1	9.7	40.7	94.9	51.8	8.2	32.0	81.9
BMI	23.7	3.1	16.3	31.6	23.2	3.3	15.4	32.9
	n	%			*n*	%		
Meal service								
Use	24	15.1			43	13.4		
Don't use	135	84.9			277	86.6		
Dental situation								
Can chew almost everything	140	88.6			296	92.5		
Can't chew well, limited in what to eat	18	11.4			24	7.5		
Disease†								
Hypertention	67	41.9			142	43.6		
Diabetes	22	13.8			28	8.6		
Dyslipidemia	18	11.3			94	28.8		
Kidney disease	9	5.6			8	2.5		
No disease	39	24.4			63	19.3		

† parameter, 160 for males and 326 for females.

Table 3. Percentage of older adults with habitual nutrient intakes below the Estimated Average Requirements (EAR), stratified by young-old and old-old population groups and sex.

		All ages					65–74 y					≥75 y				
		Male n=162		Female n=332			Male n=90		Female n=162			Male n=72		Female n=170		
		n	%	*n*	%		*n*	%	*n*	%		*n*	%	*n*	%	
Protein	<EAR	4	2.5	7	2.1	†	2	2.2	4	2.5		2	2.8	‡	3	1.8 ‡
Vitamin A	<EAR	80	49.4	71	21.4	***	46	51.1	***	46	28.4	34	47.2	***	25	14.7 §§
Vitamin B_1	<EAR	60	37.0	65	19.6	***	35	38.9	*	42	25.9	25	34.7	***	23	13.5 §§
Vitamin B_2	<EAR	24	14.8	31	9.3		16	17.8		19	11.7	8	11.1		12	7.1
Niacin	<EAR	0	0.0	0	0.0			0.0			0.0		0.0			0.0
Vitamin B_6	<EAR	29	17.9	28	8.4	**	16	17.8	*	15	9.3	13	18.1	*	13	7.6
Vitamin B_{12}	<EAR	2	1.2	3	0.9	†	1	1.1	†	2	1.2	1	1.4	‡†	1	0.6 ‡
Folate	<EAR	7	4.3	11	3.3		3	3.3	†	7	4.3	4	5.6	‡†	4	2.4
Vitamin C	<EAR	21	13.0	14	4.2	***	13	14.4	*	9	5.6	8	11.1	†*	5	2.9
Sodium	<EAR	0	0.0	0	0.0			0.0			0.0		0.0			0.0
Calcium	<EAR	74	45.7	116	34.9	*	42	46.7		61	37.7	32	44.4		55	32.4
Magnesium	<EAR	49	30.2	57	17.2	**	28	31.1		36	22.2	21	29.2	**	21	12.4 §
Iron	<EAR	11	6.8	12	3.6		5	5.6	†	8	4.9	6	8.3	‡†	4	2.4
Copper	<EAR	0	0.0	2	0.6	†		0.0	†	1	0.6		0.0	†	1	0.6 ‡

Chi-square test.

† Fisher's exact test used for sex difference and sex difference by age groups, ‡ Fisher's exact test used for age group difference by sex.

* 0.05, ** 0.001, *** <0.001: comparisons between males and females, § 0.05, §§ 0.001: comparisons between age groups by sex.

EAR (Estimated Average Requirment).

recorded from their most recent health examination. If this was not available, the researcher measured the participant's height using a portable measure. Weight was measured using a digital bathroom scale on two days. Weight measured on the first day was used in the present study. The Body Mass Index (BMI) for each participant was also calculated. BMI was calculated as weight (kg) divided by height (m^2). BMI less than 20.0 kg/m^2 was defined as below the targeted BMI range, BMI 20.0–24.9 kg/m^2 was defined as within the targeted

Table 4. Percentage of older adults with habitual nutrient intakes above the Tolerable Upper Intake Level (UL), stratified by young-old and old-old population groups and sex.

		All ages					65–74 y					≥75 y				
		Male n=162		Female n=332			Male n=90		Female n=162			Male n=72		Female n=170		
		n	%	n	%		n	%	n	%		n	%	n	%	
Vitamin A	>UL	1	0.6	1	0.3	†	1	0.6	† 1	0.6		0	0.0	‡ 0	0.0	‡
Vitamin E	>UL	0	0.0	0	0.0			0.0		0.0			0.0		0.0	
Niacin	>UL	0	0.0	0	0.0			0.0		0.0			0.0		0.0	
Vitamin B_6	>UL	0	0.0	0	0.0			0.0		0.0			0.0		0.0	
Folate	>UL	3	1.9	6	1.8	†	2	2.2	† 3	1.9		1	1.4	‡† 3	1.8	‡
Calcium	>UL	0	0.0	0	0.0			0.0		0.0			0.0		0.0	
Phosphorous	>UL	0	0.0	0	0.0			0.0		0.0			0.0		0.0	
Iron	>UL	0	0.0	0	0.0			0.0		0.0			0.0		0.0	
Copper	>UL	0	0.0	0	0.0			0.0		0.0			0.0		0.0	

Chi-square test.
† Fisher's exact test used for sex difference and sex difference by age groups, ‡ Fisher's exact test used for age group difference by sex.
UL (Tolerable Upper Intake Level).

BMI range, BMI 25.0 kg/m^2 and over was defined as above the targeted BMI range for 65–69 y. BMI less than 21.5 kg/m^2 was defined as below the targeted BMI range, BMI 21.5–24.9 kg/m^2 was defined as within the targeted BMI range, BMI 25.0 kg/m^2 and over was defined as above the targeted BMI range for 70 y or older.

Self-administered questionnaire. The self-administered questionnaire collected information including sex, age, meal service use, dental condition, and diseases.

Statistical analysis. Participants' usual intakes of the distribution of nutrients were estimated with the best-power method (*21*, *22*), using the Estimate of Distributions of Usual Dietary Intake software Version 1.2., which estimates the usual intake distribution from a few days of dietary survey (*23*, *24*). We used two days of dietary survey data to estimate the usual intake. Data for 494 older adults (162 male, 332 female) from 988 d were evaluated to assess nutrient intake. In Japan, the elderly are usually categorized into two groups: the young-old population (65–74 y) and the old-old population (75 y or older). Age categories for DRIs of adults over 65 y are 65–69 y and 70 y or older. We evaluated the nutritionally-at-risk population by comparing the estimated intakes with specific 2015 age–sex DRIs (*25*). Therefore elderly 70–74 y old were evaluated with DRI reference values for age 70 y or older. The proportion of inadequate nutrient intake was assessed using the Estimated Average Requirement (EAR) cut-point method for 14 nutrients, Tolerable Upper Intake Level (UL) for nine nutrients, and tentative dietary goal for preventing life-style related diseases (DG) for six nutrients (Table 1). EARs of some nutrients were possible to calculate using reference value, weight, energy intake and protein intake, but we didn't use reference value and instead accepted the use of tabulated EAR in this study. Data were analyzed with IBM SPSS Statistics for Windows, Version 22.0 (IBM Corp., Armonk, NY). The proportion of inadequate intake between males and females and between young-old and old-old population groups (65–74 y and 75 y or older) were compared using chi-square or Fisher's exact tests as appropriate. p values of less than 0.05 were considered statistically significant.

RESULTS

Table 2 summarizes the characteristics of the participants. For males, those below, within and above the targeted BMI range accounted for 10.3%, 54.0% and 35.6% for 65–74 y and 31.0%, 35.2% and 33.8% for 75 y or older. Mean (SD) of BMI was 24.1 (3.1) kg/m^2 for 65–74 y and 23.2 (3.1) kg/m^2 for 75 y or older. For females, those below, within and above the targeted BMI range constituted 19.3%, 49.1% and 31.7% for 65–74 y and 40.1%, 40.7% and 19.2% for 75 y or older. Mean (SD) of BMI was 23.6 (3.4) kg/m^2 for 65–74 y and 22.8 (3.2) kg/m^2 for 75 y or older. The mean (SD) of energy intake for participants 65–74 y and 75 y or older was 2,162 (565) kcal and 2,166 (494) kcal for males. For females 65–74 y and 75 y or older it was 1,805 (357) kcal and 1,746 (412) kcal. The estimated proportion of participants below EAR for their usual nutrient intake by young-old and old-old population groups and sex is shown in Table 3. The estimated proportions of male participants with a usual intake of vitamin A, vitamin B_1, vitamin B_6, vitamin C, calcium, and magnesium below EAR were higher than those of females for all ages. For males, vitamin A (49.4%) had the highest estimated proportion of participants below EAR, followed by calcium (45.7%). For females, the highest proportion of participants below EAR was for calcium (34.9%). There were no differences between the young-old and old-old

Table 5. Percentage of older adults with habitual nutrient intakes within or above the range of the Tentative DG, stratified by young-old and old-old population groups and sex.

		All ages				65–74 y				≥75 y			
		Male n=162		Female n=332		Male n=90		Female n=162		Male n=72		Female n=170	
		n	%	n	%	n	%	n	%	n	%	n	%
%energy from protein	within theDG range	134	82.7	311	93.7 ***	72	80.0 **	149	92.0	62	86.1 *	162	95.3
%energy from fat	within theDG range	91	56.2	247	74.4 ***	42	46.7 ***	116	71.6	49	68.1 §§	131	77.1
%energy from carbohydrates	within theDG range	109	67.3	278	83.7 ***	55	61.1 ***	131	80.9	54	75.0 *	147	86.5
Dietary fiber	>DG	67	41.4	213	64.2 ***	36	40.0 ***	99	61.1	31	43.1 ***	114	67.1
Salt	<DG	19	11.7	32	9.6	11	12.2	16	9.9	8	11.1	16	9.4
Potassium	>DG	93	57.4	260	78.3 ***	50	55.6 **	118	72.8	43	59.7 ***	142	83.5 §

Chi-square test.
† Fisher's exact test used for sex difference and sex difference by age groups, ‡ Fisher's exact test used for age group difference by sex.
* 0.05, ** 0.001, *** <0.001: comparisons between males and females, § 0.05, §§ 0.001: comparisons between age groups by sex.
DG (Tentative Dietary Goal for Preventing Life-style Related Diseases).

population groups for males. However, more females aged 65–74 had a usual intake of vitamin A, vitamin B_1 and magnesium below EAR than females 75 y or older.

The estimated proportion of participants with a usual nutrient intake above UL by young-old and old-old population groups and sex is shown in Table 4. There were no differences between males and females or between young-old and old-old population groups. The estimated proportion of folate above UL was 1.9% for males and 1.8% for females in all ages.

The estimated proportion of participants within the DG range, and above or below DG for the usual intake of nutrients by young-old and old-old population groups and sex is shown in Table 5. The estimated proportion of female participants with a usual nutrient intake within the DG range in terms of the percentage of energy from protein, fat, and carbohydrates was higher than in males in both the young-old and old-old population groups. The estimated proportion of participants above DG for usual intake of dietary fiber and potassium was the same. However, a higher estimated proportion of males aged 75 y or older was within the range of DG for usual intake of percentage of energy from fat than of those aged 65–74 y. The estimated proportion of females with a usual intake of potassium above DG was higher for those aged 65–74 y than for those aged 75 y or older. For salt, the estimated proportions were 11.7% for males and 9.6% for females in all population groups.

DISCUSSION

In the present study, we estimated the prevalence of inadequate nutrient intake in Japanese community-dwelling older adults who lived alone. For vitamin A, vitamin B_1, vitamin B_6, vitamin C, calcium, and magnesium, males had a higher estimated proportion of participants with a usual intake below EAR than females in all population groups. In addition, more females showed a higher percentage of energy from protein, fat, and carbohydrates within the DG range, and had a usual intake of dietary fiber and potassium above DG than males. These results suggest that Japanese male older adults are more vulnerable in terms of nutrient intake compared with females; these findings are consistent with previous studies that suggested males were at greater risk of poor diets (*8*, *26*), although different research methods mean that the results could not be easily compared. In this study, we used tabulated EAR, but if we calculated EAR, using reference value and other measures, there is a possibility that the percentage of those below EAR might be different from the results of this study.

Cooking skills are a key factor in improving the nutritional status of male older adults. A study with Taiwanese older adults found that people who cooked more frequently had better diets and more favorable nutrient densities (*27*). Another study conducted in England that targeted male older adults who lived alone reported that good cooking skills were associated with a healthier diet (*28*). However, it is not easy to learn cooking skills at an older age. A previous study investigating living arrangements and dietary intake found that living alone was associated with poor diets in males, but not females (*6*). Sex-role differentiation in food preparation activities practiced over a lifetime mean that older males may have difficulty in preparing adequate meals for themselves when they live alone (*6*). A report of international comparisons of housekeeping suggested that only 1.4% of husbands had a principle role in meal preparation in Japan, with this percentage being 16.6% in the U.S.,

and 14.8% in Sweden (*29*). Therefore, it is important to involve males in meal preparation activities from a young age so they gain these skills early, rather than needing to acquire such skills when they are older or have lost their spouse.

Another measure to improve nutritional status of older adults is incorporating home-delivered meals. A recommended home-delivered meal program was found to increase the nutrient intake in older adults in the U.S. (*30*). Takeyama and Suzuki reported that 20% of Japanese older adults who lived alone were receiving home-delivered meals, although the sample size was limited (*31*). In the present study, only 15% of males and 13% of females reported that they used a meal service, including home-delivered meals. This suggests a different approach is needed, for example, increasing access to home-delivered meals for older adults as they age and providing nutritional education including cooking skills for younger older adults, particularly males.

In the present study, we assessed inadequate nutrient intake between young-old and old-old population groups of older adults. The estimated proportion of female participants aged 65–74 y that had a usual intake below EAR for vitamin A, vitamin B_1 and magnesium was higher than for those aged 75 y or older; with a lower proportion of females in the group aged 65–74 y having a usual intake of potassium above DG than of those aged 75 y or older. However, the estimated proportion of participants within the DG range for their usual intake of percentage of energy from fat was higher in males aged 75 y or older than in those aged 65–74 y. Some studies have identified a trend of decreasing nutrient intake with increasing age (*32*), whereas several other studies have shown no specific differences in nutrient intake by age (*26*, *33*). However, this may be due to differences in study design and statistical methodology. The present study compared the proportion of inadequate nutrient intake between older adults based on age and sex, whereas other studies have compared the average intake of energy and nutrients. Further, the age group criteria for the Japanese DRIs have values related to older adults in two categories: 50–69 y and 70 y or older. More defined DRI age categories for older adults are needed, particularly as Japanese DRIs highlight the importance of detailed age categories for older adults (*25*). Further study is needed to clarify the nutritional situation of older adults by age group. In addition, the adequacy of reference intakes for older adults should also be considered.

Limitations. A limitation of our study is that we could not adjust for factors that are thought to be associated with malnutrition or under-nutrition in older adults, for example, dental condition and loss of appetite caused by medication side effects (*34–36*). Our questionnaire included questions about chewing for dental condition, but did not cover medication.

Participants in the present study first responded by postal mail and then participated in a 2-d dietary survey. Therefore, it is conceivable that our participants were well motivated to care about their health and had better health and nutritional status than older adults who did not participate. It is possible that older adults who chose not to participate in our study had more nutritional problems. Consequently, the generalizability of our findings may be limited.

Our study clarified the problems of nutrition among older adults. Interventions to improve dietary intake for older adults, especially for males, are needed.

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Conflict of interest

The authors have no potential conflicts of interest to declare.

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