Association between frequency of snacking and all-cause mortality among community-dwelling young-old adults: An age-specific prospective cohort study

Tohru Kobayashi[1,2], Wenjing Zhao[3] ,Shigekazu Ukawa[4], Kenji Wakai[5], Kazuyo Tsushita[6], Takashi Kawamura[7], Masahiko Ando[8], and Akiko Tamakoshi[3]

[1]Department of Public Health, Hokkaido University Graduate School of Medicine, North 15 West 7 Kita-ku, Sapporo, 060-8638, Japan

[2]Department of Food Science and Human Wellness, Rakuno Gakuen University, 582 Bunkyodai-Midorimachi, Ebetsu, 069-8501, Japan

[3]Department of Public Health, Hokkaido University Faculty of Medicine and Graduate School of Medicine, North 15 West 7 Kita-ku, Sapporo, 060-8638, Japan

[4]Research Unit of Advanced Interdisciplinary Care Science, Osaka City University Graduate School of Human Life Science, 3-3-138 Sugimoto, Sumiyoshi-ku, Osaka, 558-8585, Japan

[5]Department of Preventive Medicine, Nagoya University Graduate School of Medicine, 65 Tsurumai-cho, Showa-ku, Nagoya, 446-8550, Japan

[6]Comprehensive Health Science Center, Aichi Health Promotion Foundation, 1-1 Aza Gengoyama, Oaza Morioka, Higashiura-Cho, Aichi, 470-2101, Japan

[7]Kyoto University Health Service, Kyoto, 54 Kawahara-cho, Shogoin, Sakyo-ku, Kyoto, 606-8507, Japan

[8]Center for Advanced Medicine and Clinical Research, Nagoya University Hospital, 65 Tsurumai-cho, Showa-ku, Nagoya, 446-8560, Japan

Corresponding author: Akiko Tamakoshi, Department of Public Health, Hokkaido University Faculty of Medicine and Graduate School of Medicine, North 15 West 7 Kita-ku, Sapporo, 060-8638, Japan

Tel: +81-11-706-5068; Fax: +81-11-706-7805

E-mail: tamaa@med.hokudai.ac.jp

Short running title: Frequency of snacking and mortality

Abstract

Aim: We aimed to clarify whether snacking habits decrease the risk of all-cause mortality in an older Japanese population.

Methods: The study participants were 64- or 65-year-old community-dwelling residents recruited each survey year from 1996 through 2005. Data on the frequency of snacking and other lifestyle factors were obtained during the baseline survey using self-administered questionnaires, and the participants were followed up annually until the end of 2017. A total of 2943 participants (1484 males and 1459 females) were eligible. All-cause mortality was compared among participants grouped by frequency of snacking (no snacking, 1–4 times/week, or everyday).

Results: The number of deaths recorded over the study period of 43,204 person-years was 357 (24.1%) for males and 173 (11.9%) for females. The mean and standard deviation of follow-up period were 14.2 ± 4.9 years in males and 15.2 ± 4.5 years in females. Cox proportional hazard regression analyses showed that after adjusting for potential confounding factors, the hazard ratios for the females were 0.64 (95% confidence interval [CI], 0.43–0.94) in the group that had a habit of snacking 1–4 times/week and 0.93 (95%CI, 0.63–1.36) in the group that had a habit of snacking everyday compared with that in the no snacking group. These associations were not observed among males.

Conclusions: A moderate frequency of snacking slightly decreases the risk of all-cause mortality among females. Our findings may be useful for improving the nutrition statuses in older female adults.

Key words: eating behavior, epidemiology, mortality, older adults snacking,

Introduction

Snacking is a common eating habit among adults worldwide. According to the results of the National Health and Nutrition Examination Surveys conducted in the United States in 2009–2014, 88% of the surveyed adults consumed at least one snack per day.[1] According to the results of Japan's National Health and Nutrition Survey in 2007, 26.0% of the surveyed adults ate snacks everyday.[2] Frequent snacking contributes to excessive energy intake [3], and is associated with obesity and high waist circumference among adults.[4,5] In addition, nighttime snacking is a risk factor for chronic kidney disease among middle-aged or older men.[6,7] Therefore, it may be important to pay attention to the snacking habits among adults to prevent the occurrence of chronic diseases and improve body weight.

Conversely, snacking habits are useful for improving the nutrition statuses of older people.[8] Older adults who consumed snacks frequently had a faster gait speed than those who consumed snacks less frequently[9]; and who consumed snacks three times or more per day tended to have a low risk of malnutrition.[10] Thus, snacking may improve nutritional and physical conditions among older adults. However, previous findings had several limitations such as cross-sectional design[6,9,10] or short-term follow-up[7]; furthermore, no study has clarified the effect of the frequency of snacking on mortality. Therefore, the longitudinal effect of snacking on the health statuses in older adults is unclear. Furthermore, although there is a gender difference in an effect of dietary factors on health condition among middle age and older adults; for example, a diet rich in whole grain and legumes decreases a risk of hypertension only in women,[12] and abundant intake of vegetable and fruits is inversely associated with obesity especially among women,[13] risks on frequency of snacking obtained by previous studies were not

stratified by gender.[6,7,9,10] Moreover, only few studies have investigated the effect of frequency of snacking on health statuses among Japanese older adults.[6,7]

This study aimed to investigate whether snacking can decrease the risk of all-cause mortality in a population of community-dwelling young-old Japanese adults. In addition, since inadequate energy intake is known as an important risk factor for malnutrition and weight loss among older adults,[11] we stratified participants according to levels of energy intake and repeated the analysis.

Methods

Study population

The study population was extracted from the New Integrated Suburban Seniority Investigation (NISSIN) Project, an ongoing age-specific prospective cohort study established in 1996 in Nisshin City, Aichi Prefecture, central Japan. The study design, participants and other parameters were described in detail in elsewhere.[14] In brief, the study participants were community-dwelling residents who were going to turn 65 years old in each survey year and recruited at the beginning of June from 1996 through 2005. They were asked to attend a free comprehensive health examination and submit a detailed and completed self-administered questionnaire during the baseline survey. Among the eligible residents, 3073 (43.9%) individuals voluntary came to the medical check-up and provided consent to participate in the study. Of all the eligible participants, those who moved out of the city before the follow-up started (n=2), those who did not report data on snacking habits (n=17), and those who did not report information on dietary consumption (n=111) were excluded. Thus, a total of 2943 participants (1484 males and 1459 females) were included.

This study was conducted according to the guidelines laid down in the Declaration of Helsinki and the study protocol was approved by the Ethics Committee of each research institutions; Hokkaido University Graduate School of Medicine (No. 37, 2014), Aichi Medical University School of Medicine (No. 558, 2008), the National Centre for Geriatrics and Gerontology in Japan (No. 242, 2006), and Nagoya University Graduate School of Medicine (No. 162, 2002 and 2004). Informed consent was gained by an opt-out approach from 1996 to 2001 and individual written informed consent was obtained thereafter.[14]

Data collection and measures

In this study, we defined snacking as eating something between any of three main meals, i.e., breakfast, lunch and dinner, or at nighttime. Data on snacking were collected by asking participants to indicate the frequency of snacking (almost none, 1–2 times/month, 1–2 times/week, 3–4 times/week, or everyday) using self-administered questionnaires. The socio-demographic factors included education (lower than high school, high school or above, or unknown), marital status (married, other, or unknown), current employment status (employed, unemployed, or unknown) and living arrangement (alone or with others). Data on lifestyle factors included walking hours (≥1 hours, <1 hours/day, or unknown), alcohol consumption (never, 1–2 times/week, or ≥3 times/week), smoking status (never smoked, former smoker, current smoker, or unknown), sleep duration and social participation. Information on sleep duration was obtained as a self-reported continuous variable and recorded in hours and minutes per day; the recorded results were then converted into three categorical ranges of values (<7h, 7–8h, >8h/day, or unknown). Social participation was assessed using 20 items that

focused on social, educational, and individual activities. Each item had three possible responses that were assigned the following scores: not participating (1), occasionally participating (2), and regularly participating (3),[15] and the sum of the scores was calculated. The sex-specific median values of the total of the social participation scores were used to divide the participants into two categories (participating or not). Self-reported history of diseases including gastric cancer, cardiovascular disease, cerebrovascular disease, hypertension, diabetes mellitus, and dyslipidemia were collated because these diseases may affect an individual's eating habits. Height and body weight were measured using standard methods, and body mass index (BMI) was calculated using the following formula: weight (kg)/height $(m)^2$. BMI values were categorized to three groups (<18.5, 18.5–24.9 and ≥25.0).

Dietary intake during the past year was assessed using a validated food frequency questionnaire on the frequency of consumption of 90 modern Japanese food items.[16] The participants reported their average intake and frequency of consumption of each food and the usual portion of rice they consumed. The average intake of each food item per day was calculated in grams by multiplying the frequency of consumption by the given portion size. Total daily energy intake was calculated based on the information on daily food intake and the Japanese food composition table.[16] Because, recent study reported that consumption of confectioneries, beans, daily products, fruits, green/yellow vegetables and other vegetables were related to frequency of snacking among Japanese adults,[17,18] we used data on consumption of these foods as confounding factors for the analysis.

Outcomes

The participants were followed annually from the year of the baseline survey to the end of 2017, until death of any cause or they moved out of the city. The deaths or relocation dates were confirmed by the resident registry consulted by the public health nurse of the city health center.

Statistical analysis

Frequency of snacking was categorized into three groups: no snacking (almost no snacking or 1–2 times/month), 1–4 times/week, and everyday. We described the distribution of demographic and lifestyle factors according to the frequency of snacking. Chi-square test was used to compare difference of categorical variables between three groups, and one-way ANOVA was used for comparison of continuous variables. The Cox proportional hazard regression model was used to calculate the hazard ratios (HR) and 95% confidence intervals (CI) of all-cause mortality according to the frequency of snacking after adjusting for potential confounding factors. Confounding factors ranged from socio-demographic, lifestyle and dietary to history of disease (including medication situation), which may have affected snacking habit and/or mortality, according to the previous studies.[4–10] The first model included survey years, BMI, education, marital status, living arrangement and current employment status. The second model included sleep duration, social participation, walking hours, drinking and smoking status in addition to the variables included in the first model. The third model included total daily energy intake, consumption of confectioneries, beans, daily products, fruits, green/yellow vegetables and other vegetables in addition to the variables included in the second model. The fourth model included gastric cancer, cardiovascular disease, cerebrovascular disease, hypertension, diabetes mellitus and

dyslipidemia in addition to the variables included in the third model. To examine the possibility of reverse causation, the fifth model included only the participants who survived longer than two years after baseline, and adjusted the variables included in the fourth model. A sensitivity analysis was also conducted to exclude those who had a history of the aforementioned diseases at baseline, since such diseases may have affected eating behavior as well as mortality. In addition, stratified analysis was conducted for risk estimation based on tertiles of total energy intake (low, medium or high distribution calculated based on sex). All analyses were performed using JMP Pro 12.1.0 software (SAS Institute Inc. Cary, NC, USA), and statistical significance was set at $p < 0.05$.

Results

Overall, 357 (24.1%) males and 173 (11.9%) females died during the study period of 43,204 person-years. The mean ± standard deviation of the follow-up period was 14.2 ± 4.9 years in male and 15.2 ± 4.5 years in female participants. Table 1 shows the characteristics of the study participants according to frequency of snacking. Among males, those who had a habit of snacking everyday were more likely to consume low levels of alcohol, have a higher prevalence of being overweight (BMI≥25.0), have a history of gastric cancer, and consume more confectioneries and daily products than those who did not snack frequently. Among females, those who had a habit of snacking everyday were more likely to have a higher energy intake, consumption of confectioneries, prevalence of history of gastric cancer and have lower consumption of fruits, green/yellow vegetables and other vegetables than those who did not snack frequently.

Table 2 shows the HRs and 95% CIs for all-cause mortality stratified by sex. Among females, the HR was the lowest (0.63, 95%CI, 0.43–0.91) for the group of participants who had a habit of snacking 1–4 times/week, after adjustment for survey years, BMI, education, marital status, living arrangement, and current employment status. The group that had a habit of snacking everyday had a HR of 0.94 (95%CI, 0.66–1.34); however, this association was not significant. After further adjustment for sleep duration, social participation, walking hours, frequency of drinking, smoking status, total energy intake, consumption of confectioneries, beans, daily products, fruits, green/yellow vegetables, other vegetables and history of disease, the pattern of the HRs was unchanged. Moreover, the fifth model, which was restricted to the participants who survived for longer than two years, also indicated similar pattern of the HRs. The analysis was repeated on the participants who had no history of diseases and the results were not altered (Table 3). These associations were not observed among males; namely, there was no association between snacking and all-cause mortality in these participants.

Table 4 shows the HRs and 95%CIs for all-cause mortality according to tertiles of total daily energy intake. Among females, the participants in the medium tertile of total energy intake who had a habit of snacking 1–4 times/week had an HR of 0.50 (95%CI, 0.25–0.99) after full adjustment for all related variables. Similar HR patterns were observed in the lowest tertile of total energy intake, although no association was significant, and an interactive effect of frequency of snacking and total energy intake on all-cause mortality were not observed. Among males, tertiles of total daily energy intake in any case showed no significant association between snacking and all-cause mortality.

Discussion

The present study compared the risk of all-cause mortality among community-dwelling young-old adults grouped according to their snacking habits. We found that female participants who snacked 1–4 times/week showed an approximately 40% lower risk of all-cause mortality than those who had no snacking habits. This finding suggested slight but significant positive effect of moderate frequency of snacking on mortality among females. To the best of our knowledge, this is the first study to suggest the potential effect of moderate frequency of snacking on mortality among older female adults.

Several studies suggested that energy intake via snacking contributed to 20–30% of the total energy intake in older adults.[19,20] Older adults commonly have decreased appetites and declined digestive functions, which lead to a low dietary intake. Malnutrition increase the risk of hospitalization and mortality among community-dwelling older adults.[21-23] In the present study, female participants who had a habit of snacking had a tendency for higher total energy intake than those who had no habit of snacking. In addition, the results of the sensitivity analyses, which was restricted to participants who survived for longer than two years after baseline or which excluded participants with a history of diseases, were unchanged. Regardless of a history of diseases, moderate frequency of snacking may lower the risk of all-cause mortality among older female adults.

However, decrement of the HR in the group that had a habit of snacking everyday was smaller than that in the group that had a habit of snacking 1–4 times/week. Frequent snacking is related to good diet quality due to the increased intake of fruits, beans and dairy products [18,24] and abundant intake of protein, vitamins, and minerals.[25,26] Conversely, frequent snacking is related to decreased intake of

vegetables.[24] Female participants who had a habit of snacking 1–4 times/week had tendency to higher intake of beans, daily products, fruits and vegetable than those who had a habit of snacking everyday. A recent meta-analysis indicates a healthy dietary pattern is associated with lower all-cause mortality,[27] and this association was also observed consistently in two cohort studies of the Japanese population.[28,29] Therefore, moderate frequency of snacking may be associated with improved dietary quality compared to that of snacking everyday. Moreover, additional analysis stratified by total energy intake suggested that a combination of moderate total energy intake and frequency of snacking may decrease a risk of all-cause mortality. To improve and maintain health conditions in female older adults, it may be necessary to not only maintain moderate frequency of snacking but also to avoid inadequate total energy intake.

In the present study, snacking 1–4 times/week decreased the risk of all-cause mortality in females but not in males. There may be a plausible reason for this sex-related difference. Women have a tendency to choose healthy foods such as fruits and vegetables during snack time compared to men,[30] which was consistent with the our findings; consumption of these foods may have contributed to their health. In addition, frequency of snacking was associated with lower alcohol consumption among the male participants, and drinking habit might have affected their food choice. Therefore, sex-related differences in food choice during snack time may affect total energy and nutritional intake, and as a result, a habit of snacking may have a more positive effect on the nutritional conditions in young-old female adults.

The present study has some notable strengths. Using an age-specific prospective cohort of young-old adults allowed us to eliminate the effect of age on the association

between frequency of snacking and all-cause mortality. Moreover, the sensitivity analyses, which was restricted to participants who survived for longer than two years after baseline or excluding participants with history of diseases, increased the validity of the findings. However, certain limitations to the study exist. Firstly, we only collected data on the frequency of snacking habits; information on specific foods and nutrients consumed during snack time were not obtained. Therefore, we could not clarify a direct relationship between the amount of foods and nutrients consumed through snacking and mortality. However, in multivariate analysis adjusted for intake of several foods related to snacking habit, the result was not altered, i.e., snacking 1–4 times/week was still related to decreased risk for mortality among female older adults. Secondly, whether the specific timing of snacking may have lowered the risk of mortality was not clear. Although a habit of eating snacks other than the three standard meals of the day may be associated with reduced mortality among female older adults, we could not recommend a suitable timing for snacking based on the results of this study. Thirdly, the questionnaire used in this study was self-reported and the reliability and reproducibility were not examined before; thus, a probability of over or under reporting on the frequency of snacking is unclear. Finally, the relatively small sample size and limited number of deaths might have affected the statistical power of the subgroup analysis of total energy intake.

In conclusion, moderate frequency of snacking slightly decreases the risk of all-cause mortality among female young-old adults. Energy intake outside regular meals may have a positive effect on health and improve the nutrition statuses in female older adults.

Acknowledgements

We appreciate the staff from the Nisshin Medical and Dental Associations and the Health Center and Hygiene Department of Nisshin City who provided the cooperation and great effort for carrying out our study. This study was supported by a Grant-in-Aid for Scientific Research from the Ministry of Education, Culture, Sports, Science and Technology of Japan (JP15390197, JP25893003, JP2646760, JP26520105 and JP20K02392); The Uehara Memorial Foundation; Mitsui Sumitomo Insurance Welfare Foundation; Health Promotion Foundation; and Pfizer Health Research Foundation.

Disclosure statement

All authors have nothing to disclose.

References

1 Kant AK. Eating patterns of US adults: Meals, snacks, and time of eating. *Physiol Behav* 2018; 193: 270–278.

2 Ministry of Heath, Labour and Welfare. *The National Health and Nutrition Survey Japan, 2007*; 2007. Available from URL: https://www.mhlw.go.jp/bunya/kenkou/eiyou09/dl/01-04.pdf

3 Berteus Forslund H, Torgerson JS, Sjostrom L, Lindroos AK. Snacking frequency in relation to energy intake and food choices in obese men and women compared to a reference population. *Int J Obes (Lond)* 2005; 29: 711–719.

4 Peltzer K, Pengpid S. The Association of Dietary Behaviors and Physical Activity Levels with General and Central Obesity among ASEAN University Students. *AIMS public health* 2017; 4: 301–313.

5 Barrington WE, Beresford SAA. Eating Occasions, Obesity and Related Behaviors in Working Adults: Does it Matter When You Snack? *Nutrients* 2019; 11: 2320.

6 Michishita R, Matsuda T, Kawakami S, et al. The Association Between Unhealthy Lifestyle Behaviors and the Prevalence of Chronic Kidney Disease (CKD) in Middle-Aged and Older Men. *J Epidemiol* 2016; 26: 378–385.

7 Michishita R, Matsuda T, Kawakami S, et al. The association between changes in lifestyle behaviors and the incidence of chronic kidney disease (CKD) in middle-aged and older men. *J Epidemiol* 2017; 27: 389–397.

8 Nieuwenhuizen WF, Weenen H, Rigby P, Hetherington MM. Older adults and patients in need of nutritional support: review of current treatment options and factors influencing nutritional intake. *Clin Nutr* 2010; 29: 160–169.

9 Xu B, Yu GP, Zizza CA, Liu H, Zhao L. Snacking may improve physical function among older Americans. *J Nutr Health Aging* 2013; 17: 393–397.

10 van der Pols-Vijlbrief R, Wijnhoven HA, Molenaar H, Visser M. Factors associated with (risk

of) undernutrition in community-dwelling older adults receiving home care: a cross-sectional study in the Netherlands. *Public Health Nutr* 2016; 19: 2278–2289.

11 Gammack JK, Sanford AM. Caloric supplements for the elderly. *Curr Opin Clin Nutr Metab Care* 2015; 18: 32-6.

12 Song S, Kim J, Kim J. Gender Differences in the Association between Dietary Pattern and the Incidence of Hypertension in Middle-Aged and Older Adults. *Nutrients* 2018; 10: 252

13 Muga MA, Owili PO, Hsu CY, Rau HH, Chao JC. Dietary patterns, gender, and weight status among middle-aged and older adults in Taiwan: a cross-sectional study. *BMC Geriatr* 2017; 17: 268.

14 Kitamura T, Kawamura T, Tamakoshi A, Wakai K, Ando M, Ohno Y. Rationale, design, and profiles of the New Integrated Suburban Seniority Investigation (NISSIN) Project: a study of an age-specific, community-based cohort of Japanese elderly. *J Epidemiol* 2009; 19: 237–243.

15 Aoki R, Ohno Y, Tamakoshi A, et al. Lifestyle determinants for social activity levels among the Japanese elderly. *Arch Gerontol Geriatr* 1996; 22: 271–286.

16 Wakai K, Egami I, Kato K, et al. A simple food frequency questionnaire for Japanese diet--Part I. Development of the questionnaire, and reproducibility and validity for food groups. *J Epidemiol* 1999; 9: 216–226.

17 Murakami K, Livingstone MBE, Shinozaki N, et al. Food Combinations in Relation to the Quality of Overall Diet and Individual Meals in Japanese Adults: A Nationwide Study. *Nutrients* 2020; 12: 327.

18 Murakami K, Shinozaki N, Livingstone MBE, et al. Meal and snack frequency in relation to diet quality in Japanese adults: a cross-sectional study using different definitions of meals and snacks. *Br J Nutr* 2020; 124: 1219–1228.

19 Andersson J, Nydahl M, Gustafsson K, Sidenvall B, Fjellstrom C. Meals and snacks among elderly self-managing and disabled women. *Appetite* 2003; 41: 149–160.

20 Zizza CA, Tayie FA, Lino M. Benefits of snacking in older Americans. *J Am Diet Assoc* 2007; 107: 800–806.

21 Ramage-Morin PL, Gilmour H, Rotermann M. Nutritional risk, hospitalization and mortality among community-dwelling Canadians aged 65 or older. *Health Rep* 2017; 28: 17–27.

22 Shakersain B, Santoni G, Faxen-Irving G, Rizzuto D, Fratiglioni L, Xu W. Nutritional status and survival among old adults: an 11-year population-based longitudinal study. *Eur J Clin Nutr* 2016; 70: 320–325.

23 Sanchez-Rodriguez D, Marco E, Schott AM, et al. Malnutrition according to ESPEN definition predicts long-term mortality in general older population: Findings from the EPIDOS study-Toulouse cohort. *Clin Nutr* 2018; 38: 2652–2658.

24 Murakami K, Livingstone MB. Associations between Meal and Snack Frequency and Diet Quality in US Adults: National Health and Nutrition Examination Survey 2003-2012. *J Acad Nutr Diet* 2016; 116: 1101–1113.

25 Hengeveld LM, Pelgrom ADA, Visser M, Boer JMA, Haveman-Nies A, Wijnhoven HAH. Comparison of protein intake per eating occasion, food sources of protein and general characteristics between community-dwelling older adults with a low and high protein intake. *Clinical nutrition ESPEN* 2019; 29: 165–174.

26 Zizza CA, Arsiwalla DD, Ellison KJ. Contribution of snacking to older adults' vitamin, carotenoid, and mineral intakes. *J Am Diet Assoc* 2010; 110: 768–772.

27 Li F, Hou LN, Chen W, et al. Associations of dietary patterns with the risk of all-cause, CVD and stroke mortality: a meta-analysis of prospective cohort studies. *Br J Nutr* 2015; 113: 16–24.

28 Kurotani K, Akter S, Kashino I, et al. Quality of diet and mortality among Japanese men and women: Japan Public Health Center based prospective study. *BMJ* 2016; 352: i1209.

29 Nanri A, Mizoue T, Shimazu T, et al. Dietary patterns and all-cause, cancer, and cardiovascular disease mortality in Japanese men and women: The Japan public health center-based prospective

study. *PLoS One* 2017; 12: e0174848.

30 Hartmann C, Siegrist M, van der Horst K. Snack frequency: associations with healthy and unhealthy food choices. *Public Health Nutr* 2013; 16: 1487–1496.

Table 1. Characteristics of the 2,943 participants grouped according to frequency of snacking habits

Variable	Males (n = 1,484)							Females (n = 1,459)						
	No snacking habit (n = 882)		1–4 times/week (n = 344)		Everyday (n = 258)		p ‡	No snacking habit (n = 524)		1–4 times/week (n = 510)		Everyday (n = 425)		p ‡
	Mean or *n*	SD or %	Mean or *n*	SD or %	Mean or *n*	SD or %		Mean or *n*	SD or %	Mean or *n*	SD or %	Mean or *n*	SD or %	
Body mass index														
<18.5	43	4.9	10	2.9	10	3.9		26	5.0	22	4.3	25	5.9	
18.5–24.9	650	73.7	240	69.8	161	62.4	0.001	391	74.6	390	76.5	318	74.8	0.824
≥25.0	189	21.4	94	27.3	87	33.7		107	20.4	98	19.2	82	19.3	
Education (years)														
≤12	593	67.2	229	66.6	170	65.9	0.760	435	83.0	430	84.3	359	84.5	0.870
≥13	288	32.7	115	33.4	87	33.7		88	16.8	79	15.5	66	15.5	
Marital status														
Married	838	95.0	327	95.1	246	95.4	0.950	422	80.5	425	83.3	357	84.0	0.248
Unmarried	43	4.9	17	4.9	12	4.7		101	19.3	81	15.9	67	15.8	
Living arrangement														
Alone	21	2.4	10	2.9	3	1.2	0.353	45	8.6	31	6.1	30	7.1	0.293
With others	861	97.6	334	97.1	255	98.8		479	91.4	479	93.9	395	92.9	
Current employment status														
Employed	510	57.8	186	54.1	133	51.6	0.268	139	26.5	126	24.7	119	28.0	0.173
Unemployed	363	41.2	155	45.1	120	46.5		380	72.5	384	75.3	304	71.5	
Sleep duration (hours/night)														
<7	395	44.8	176	51.2	126	48.8		304	58.0	311	61.0	267	62.8	
7–8	363	41.2	133	38.7	99	38.4	0.396	187	35.7	177	34.7	142	33.4	0.488
>8	122	13.8	34	9.9	32	12.4		32	6.1	21	4.1	16	3.8	
Social participation														
Participating	462	53.4	167	50.3	122	49.4	0.430	247	49.3	256	53.4	210	51.8	0.424
Not participating	404	46.7	165	49.7	125	50.6		254	50.7	223	46.6	195	48.1	
Walking hours														
≥1 times/day	428	48.6	144	42.0	135	52.7	0.403	334	63.7	340	66.7	290	68.2	0.327
<1 times/day	452	51.4	199	58.0	121	47.3		190	36.3	170	33.3	135	31.8	
Alcohol consumption														
≥3 times/week	584	66.2	177	51.5	116	44.9		66	12.6	61	12.0	37	8.7	
1–2 times/week	36	4.1	14	4.1	10	3.8	<0.001	23	4.4	16	3.1	25	5.9	0.104
None	262	29.7	153	44.5	132	51.1		435	83.0	433	84.9	363	85.4	

Smoking status														
Current smoker	293	33.2	111	32.3	63	24.4		26	5.0	14	2.7	14	3.3	
Former smoker	418	47.4	168	48.8	136	52.7	0.214	32	6.1	28	5.4	14	3.3	0.086
Never smoked	170	19.3	65	18.9	59	22.9		466	88.9	468	91.7	397	93.4	
History of gastric cancer	8	0.9	3	0.9	8	3.1	0.017	0	0.0	2	0.3	5	1.2	0.031
History of cardiovascular disease	42	4.8	17	4.9	13	5.0	0.980	15	2.9	9	1.8	10	2.4	0.504
History of cerebrovascular disease	48	5.4	17	4.9	13	5.0	0.926	22	4.2	18	3.5	12	2.8	0.524
History of hypertension	219	24.8	106	30.8	60	23.3	0.055	115	22.0	124	24.3	91	21.4	0.515
Medication for hypertension	180	20.4	87	25.3	53	20.5	0.159	98	18.7	96	18.8	74	17.4	0.832
History of diabetes mellitus	90	10.2	43	12.5	24	9.3	0.383	34	6.5	24	4.7	14	3.3	0.075
Medication for diabetes mellitus	59	6.7	32	9.3	14	5.4	0.145	18	3.4	15	2.9	11	2.6	0.744
History of dyslipidemia	76	8.6	39	11.3	27	10.5	0.300	90	17.2	90	17.7	67	15.8	0.734
Medication for dyslipidemia	41	4.7	26	7.6	19	7.4	0.076	57	10.9	58	11.4	40	9.4	0.608
Total energy intake (kcal/day)†	1,900	602	1,930	649	1,892	644	0.701	1,834	664	1,894	613	2,077	733	<0.001
Confectioneries (g/1,000kcal)	4.8	5.3	7.9	6.5	10.0	9.0	<0.001	8.5	8.9	9.6	7.2	14.3	10.1	<0.001
Beans (g/1,000kcal)†	39.3	25.2	37.6	20.4	38.0	18.7	0.452	46.5	26.8	47.2	27.6	43.9	24.1	0.137
Dairy products (g/1,000kcal)†	87.0	78.3	74.2	59.0	94.0	79.2	0.003	114.4	83.9	115.6	75.3	105.5	74.2	0.107
Fruits (g/1,000kcal)†	82.1	62.9	83.2	54.3	89.0	55.0	0.259	131.0	77.8	138.0	74.9	124.2	66.4	0.017
Green/Yellow vegetables (g/1,000kcal)†	53.5	47.4	54.1	47.1	56.0	44.2	0.760	74.8	52.8	74.8	50.2	64.0	44.4	0.001
Other vegetables (g/1,000kcal)†	58.4	28.5	58.9	26.0	61.3	29.3	0.337	74.2	32.5	74.5	31.0	68.0	30.3	0.002

SD, standard deviation.

†Data are presented as mean and SD.

‡Chi square test was used to compare difference of categorical variables, one-way ANOVA was used for comparison of continuous variables.

Table 2. Associations between snacking habits and all-cause mortality among the participants

	No snacking habit		1–4 times/week		Everyday		Trend *p*
	HR[†]	95% CI[‡]	HR[†]	95% CI[‡]	HR[†]	95% CI[‡]	
Males (n = 1,484)							
Cases/person-years	209/12514		86/4896		62/3662		
Model 1	1.00	Reference	1.03	0.80–1.32	0.93	0.69–1.24	0.831
Model 2	1.00	Reference	0.98	0.75–1.28	0.99	0.73–1.34	0.987
Model 3	1.00	Reference	1.00	0.76–1.32	1.04	0.76–1.42	0.966
Model 4	1.00	Reference	1.01	0.77–1.32	1.07	0.77–1.45	0.923
Males who survived longer than two years (n = 1,448)							
Cases/person-years	204/12494		79/4884		61/3657		
Model 4	1.00	Reference	0.94	0.71–1.24	1.08	0.78–1.48	0.755
Females (n = 1,459)							
Cases/person-year	73/7928		46/7880		54/6323		
Model 1	1.00	Reference	0.63	0.43–0.91	0.94	0.66–1.34	0.038
Model 2	1.00	Reference	0.62	0.43–0.91	0.97	0.67–1.39	0.038
Model 3	1.00	Reference	0.62	0.42–0.91	0.93	0.63–1.36	0.044
Model 4	1.00	Reference	0.64	0.43–0.94	0.93	0.63–1.36	0.064
Females who survived longer than two years (n = 1,425)							
Cases/person-years	70/7921		45/7872		50/6306		
Model 5	1.00	Reference	0.65	0.43–0.95	0.89	0.60–1.33	0.089

[†]HR, hazard ratio

[‡] CI, confidence interval

HR estimated with Cox hazard regression and 95% CI.

Model 1: Adjusted for survey years, body mass index, education, marital status, living arrangement, and current employment status.

Model 2: Adjusted for the variables included in the Model 1, in addition to sleep duration, social participation, walking hours, alcohol consumption, and smoking status.

Model 3: Adjusted for the variables included in the Model 2, in addition to intake of total energy, confectioneries, beans, daily products, fruits, green/yellow vegetables, and other vegetables.

Model 4: Adjusted for the variables in Model 3, in addition to history of gastric cancer, cardiovascular disease, cerebrovascular disease, History of hypertension, diabetes mellitus, and dyslipidemia.

Model 5: Participants who survived longer than two years after baseline, in addition to adjustment for the variables included in the Model 4.

Table 3. Associations between snacking habits and all-cause mortality for participants with no history of diseases.

	No snacking habit		1–4 times/week		Everyday		Trend *p*
	HR[†]	95% CI[‡]	HR[†]	95% CI[‡]	HR[†]	95% CI[‡]	
Males (n = 836)							
Cases/person-years	124/7213		40/2570		34/2095		
Model 1	1.00	Reference	0.89	0.62–1.27	0.87	0.59–1.29	0.695
Model 2	1.00	Reference	0.79	0.54–1.15	1.00	0.66–1.52	0.440
Model 3	1.00	Reference	0.82	0.56–1.22	1.08	0.70–1.66	0.520
Males who survived longer than two years (n = 817)							
Cases/person-years	119/7197		37/2566		33/2093		
Model 4	1.00	Reference	0.78	0.52–1.17	1.07	0.69–1.67	0.401
Females (n = 878)							
Cases/person-years	44/4587		24/4680		33/3992		
Model 1	1.00	Reference	0.55	0.34–0.91	0.91	0.58–1.44	0.059
Model 2	1.00	Reference	0.58	0.35–0.96	0.94	0.58–1.50	0.091
Model 3	1.00	Reference	0.55	0.33–0.92	0.82	0.50–1.34	0.075
Females who survived longer than two years (n = 854)							
Cases/person-years	42/4581		23/4576		30/3979		
Model 4	1.00	Reference	0.55	0.32–0.92	0.77	0.46–1.29	0.078

[†]HR, hazard ratio

[‡]CI, confidence interval

HR estimated with Cox hazard regression and 95% CI.

Model 1: Adjusted for survey years, body mass index, education, marital status, living arrangement, and current employment status.

Model 2: Adjusted for the variables included in the Model 1, in addition to sleep duration, social participation, walking hours, alcohol consumption, and smoking status.

Model 3: Adjusted for the variables included in the Model 2, in addition to intake of total energy, confectioneries, beans, daily products, fruits, green/yellow vegetables, and other vegetables.

Model 4: Participants who survived longer than two years after baseline, in addition to adjustment for the variables included in the Model 2.

Table 4. Associations between snacking habits and all-cause mortality according to tertiles of total energy intake.

	No snacking habit		1–4 times/week		Everyday		Trend *p*
	HR[†]	95% CI[‡]	HR[†]	95% CI[‡]	HR[†]	95% CI[‡]	
Males (n = 1,484)							
Total energy intake (kcal)							
Low (<1598)							
Cases/person-years	62/3968		28/1721		22/1279		
	1.00	Reference	0.84	0.49–1.38	1.10	0.61–1.92	0.674
Medium (1598–2068)							
Cases/person-years	70/4636		25/1431		22/1025		
	1.00	Reference	0.92	0.54–1.52	1.29	0.69–2.33	0.597
High (>2068)							
Cases/person-years	77/3909		33/1744		18/1358		
	1.00	Reference	0.95	0.60–1.50	0.66	0.36–1.15	0.360
Females (n = 1,459)							
Total energy intake (kcal)							
Low (<1614)							
Cases/person-years	32/2968		16/2617		14/1759		
	1.00	Reference	0.77	0.37–1.52	0.74	0.34–1.51	0.635
Medium (1614–2046)							
Cases/person-years	28/2879		16/2691		14/1782		
	1.00	Reference	0.50	0.25–0.99	0.64	0.30–1.31	0.131
High (>2046)							
Cases/person-years	13/2081		14/2572		26/2783		
	1.00	Reference	0.78	0.33–1.83	1.55	0.74–3.42	0.173

[†]HR, hazard ratio

[‡]CI, confidence interval

HR estimated with Cox hazard regression and 95% CI.

Adjusted for survey years, body mass index, education, marital status, living arrangement, current employment status, sleep duration, social participation, walking hours, alcohol consumption, smoking status, intake of total energy, confectioneries, beans, daily products, fruits, green/yellow vegetables, other vegetables, history of gastric cancer, cardiovascular disease, cerebrovascular disease, hypertension, diabetes mellitus, and dyslipidemia.