Original Article

Dietary diversity and food choice motives during the COVID-19 pandemic among older Japanese: An Internet Panel Survey

Mariko Nakamoto RD, PhD, Miku Kanmura RD, BS, Mai Yoshida RD, BS, Kana Yamada RD, BS, Akiko Nakamoto RD, PhD, Tohru Sakai RD, PhD

Department of Public Health and Applied Nutrition, Institute of Biomedical Sciences, Tokushima University Graduate School, Tokushima, Japan

Background and Objectives: We examined how food choice motives and dietary habits changed during the COVID-19 pandemic. **Methods and Study Design:** Four hundred elderly Japanese completed an online questionnaire in early May in 2021. Participants were retrospectively asked about their intake of food groups and food choice motives before and during the COVID-19 pandemic. Dietary diversity was determined using the dietary variety score calculated from the food frequency questionnaire with 10 food groups. The importance of each of the nine food choice motives for elderly people was assessed. Each scores ranged from 1 to 5. Changes in food choice motives and dietary behaviors during the COVID-19 pandemic were assessed using the paired t-test and a general linear model. **Results:** Among the food choice motives, scores for the importance of weight control, physical well-being and economical efficiency significantly increased in both sexes (all $p<0.05$). Dietary diversity score was lower during the COVID-19 pandemic than that before the pandemic in women ($p=0.019$), but there was no difference in men. In the multivariate adjustment model, physical well-being and economical efficiency were shown to have significant positive associations with the COVID-19 pandemic in women ($p=0.034$ and 0.009, respectively). In contrast, eating out was shown to have a significant inverse association with the COVID-19 pandemic in women ($p=0.009$). **Conclusions:** The findings suggest that the COVID-19 pandemic was associated with an increase in some food choice motives and a decrease in the frequency of eating out among elderly female Japanese.

Key Words: COVID-19, dietary diversity, food choice motive, older Japanese

INTRODUCTION

COVID-19 spread worldwide and the World Health Organization issued a pandemic declaration in March 2020.[1] This COVID-19 pandemic affected the global economy through damaging economic systems involving trade complementarity, capital, materialism and cash flow[2-4] in addition to the deaths of many infected people.[5] Especially, Japan had one of the earliest exposures to coronavirus through the Cruise Ship incident,[5] and the policy dilemma of the Olympic Games. Lockdowns were implemented in many countries including the United States, France, and Spain to prevent the rapid spread of COVID-19, and the first national emergency declaration was also issued in Japan from April to May in 2020.[6] During the state of emergency in Japan, it was possible to go out when necessary, but there were major changes in daily life such as working from home and refraining from going out unnecessarily. By such domestic COVID-19 infection control, Japan is known to be lowest area of clinical manifestation and mortality rate.[5] Actually, on April 1, 2022, the total number of COVID-19 cases in Japan reported by the Ministry of Health, Labor and Welfare was 6,538,890, which is about 5.2% of the total population.[7] The proportion of people who became severely ill and the proportion of people who died from COVID-19 differed depending on age. The proportions of people in their 50s or younger and in their 60s or older who became severely ill were 0.03 % and 2.49 %, respectively. The proportions of people in their 50s or younger and in their 60s or older who died from COVID-19 were 0.01 % and 1.99 %, respectively.[7] From the early days of the COVID-19 pandemic, it was reported that elderly people were more likely to become ill, and elderly people had severe restrictions in daily life.

Until now, dietary quality (e.g. mediterranean diet) and nutritional status have been reported to be important factors for infection and/or severity of coronavirus.[8-10] At the same time, it is also being reported that the COVID-19

Corresponding Author: Dr Mariko Nakamoto, Department of Public Health and Applied Nutrition, Institute of Biomedical Sciences, Tokushima University Graduate School, 3-18-15 Kuramoto-cho, Tokushima City, Tokushima 770-8503, Japan.
Tel: +81-886-33-7476
Email: nakamoto@tokushima-u.ac.jp
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pandemic might change habitual eating behaviors that normally do not change. Human eating behavior is a habit that is established by repeating it every day.[11] Since food selection behavior has the characteristic of selecting similar things every day, food selection behavior after adulthood tends to become stable and difficult to change. In a longitudinal study of dietary patterns in Chinese adults from 1991 to 2009, the correlation coefficient between dietary pattern scores obtained at an 18-year interval (1991-2009) was 0.68, which is a general dietary pattern. It has been reported that dietary pattern remained stable over time.[12] A similar study was conducted in Japanese at 1-year intervals, and it was reported that there was a correlation coefficient between dietary pattern scores of 0.55 for male 'westernized patterns' and female 'cautious patterns' for males and a correlation coefficient ranging up to 0.77 for the 'traditional pattern'.[13] However, habits are vulnerable to change when there is a major change in the environment or attributes in which they are placed.[14] Major changes in the environment include preventive changes in lifestyle that were taken with the spread of COVID-19. A study in which changes in dietary motivation during lockdown due to COVID-19 in France were investigated showed increasing importance, convenience and familiarity with mood, weight management, health, ethical interests, natural ingredients and sensory appeal and reducing importance of price.[15] We also investigated changes in nutritional value and we found a 14% increase in energy intake and a decrease in dietary nutritional value during lockdown.[15] Thus, preventive measures associated with the spread of COVID-19 might have significantly changed people's lives and might also have changed the decision-making process at the time of food selection and the eating behavior and food intake that are the result of food selection. However, there have been no studies in which changes in food choice motive and dietary habits including dietary intake after the spread of COVID-19 were investigated for Japanese elderly people.

Thus, the aim of this study was to clarify the changes in food choice motives and dietary habits including dietary intake before and after the first state of emergency in the elderly, who are more likely to become severely ill from COVID-19.

METHODS

Study subjects

We conducted an Internet panel survey that included participants who were already registered with an Internet survey company (ASMARQ Co., Ltd.). The Internet panel survey was conducted between May 13, 2021 and May 14, 2021 for Internet users aged 60 years or older in all over Japan. For survey participants registered in advance, questionnaires and a response column were displayed on the website for the respondents to complete and transmit their responses. A total of 400 people who had registered with the survey company took part in the present study. The participants were extracted on the basis of the population composition ratios for residential areas so as to make a male/female ratio of 1:1. Participants were those who completed the survey (Supplemental table 1). All of the people who were registered with the survey company had been registered by open recruitment. In January 2019, the total number of monitors was about 900,000. As a countermeasure against incorrect answers, at the time of registration, a system check was performed to prevent duplicate registration and registration inconsistency points based on some registration information as well as a mandatory update of monitor registration information once a year.

The study protocol was approved by the institutional review boards of Tokushima University Hospital (ethical approval number: 3963). Personal information and privacy protection are contracted between the registered monitor and the research company and are completely protected. Cooperation in this study was considered to have been agreed upon by responding to the survey.

Dietary assessment and dietary diversity assessment

Dietary intake habits were assessed by simply asking about the frequencies of intake of the following 10 food groups: fish and shellfish, meats, eggs, milk and dairy products, legumes, deep yellow vegetables, seaweed, potatoes, fruits, fats and oil. The participants answered simple questions regarding the frequencies of consumption of the 10 food items per week (how many times consumed per week). The frequency of food intake was classified into the following four categories: 'every day' (7 times/week), 'once every two days' (3-4 times/week), 'once or twice a week' (1-2 times/week) and 'almost never' (0 times/week).

We assessed dietary diversity using the frequencies of intake of the 10 food groups based on dietary variety score (DVS) proposed by Kumagai et al.[16] DVS is a scale for dietary diversity with possible scores ranging from 0 to 10 points. The total DVS score was calculated as the sum of all 10 food items according to 'every day' as 1 point and 'once every two days', 'once or twice a week' and 'almost never' as 0 points.[16]

Regarding dietary behavior, we obtained information on the weekly frequency (times/week) for self-cooking meal, eating out, snacks, skipping meals, eating alone, use of supplements were collected using online open-ended questions.

Assessment of food choice motives

Food choice motives were evaluated using the Food Choice Questionnaire for Japanese Elderly (FCQ-E).[17] FCQ-E consists of 27 items of 9 factors and was developed by Kato as a questionnaire with measurable characteristics of various food selection motives (Supplemental table 2). Since the questionnaire has only a small number of questions and is simple, it is used as a suitable scale for the elderly. The reliability, criteria-related validity, and certain convergent validity of the questionnaire have been confirmed in 385 healthy elderly people (whose score of the older research activity ability index is 10 points or more, 20.8% for men and 79.0% for women) aged 60 years or older who were living in Kyoto City, Kyoto Prefecture and Takarazuka City, Hyogo Prefecture.[18] In the questionnaire, it is asked "How important is each of the following 9 factors when choosing foods?": 1) sensory/mood, 2) quality clarity, 3) weight control, 4) physical well-being, 5) nutrition balance, 6) convenience of cooking, 7) familiarity, 8) relationship with others, and 9) eco-

nomical efficiency. The participants answered the question to chose between five responses: not at all important, not very important, a little important, moderately important and very important, scored 1 to 5.

Other measurements

Higher-level functional capacity was assessed by using the Tokyo Metropolitan Institute of Gerontology Index of Competence (TMIG-IC). The TMIG-IC is a widely used scale for evaluation of activities of daily living based on Lawton's hierarchical model of behavioral competence among the elderly.[19] It is a multi-dimensional evaluation method consisting of 13 items with the following three subscales: Instrumental Self Maintenance (five items), Intellectual Activity (four items) and Social Role (four items). The response to each item is scored either 'yes' (able to do) for 1 point or 'no' (unable to do) for 0 points, with possible scores ranging from 0 to 13 points. A higher score reflects higher functional capability. In this study, participants with a total TMIG-IC score >10 were considered as being 'able to independently live in the community'.[20,21]

Data regarding gender, age, body weight, living area, current and previous histories of diseases, health status, cohabitation situation, level of education, annual household income, current physical activity, frequency of going out, chatting time, TV viewing time, sleep time, drinking habits and smoking habits were collected using online open-ended questions.

Statistical analysis

Continuous variables were expressed as means ± standard deviation (SD), and categorical variables were expressed as numbers and proportions (%).

We used the paired t-test to assess the differences in food choice motives and dietary habits before and during the COVID-19 pandemic. Furthermore, to assess the differences in food choice motives and dietary habits according to the COVID-19 pandemic, we used a generalized linear model after controlling for the following variables. The confounding variables were 1) Age-adjusted model, age (continuous, years); 2) Multivariable-adjusted model, age-adjusted model + living area (categorical; Hokkaido, Tohoku, Kanto, Chubu, Kansai, Chugoku/Shikoku or Kyushu), living status (binary; living alone or cohabitation), level of education (categorical; <9 years, 9-12 years or >12 years), annual household income (categorical; <1.49 million yen, 1.5-5.49 million yen, >5.5 million yen or unknown), smoking habits (categorical; current, former or never), drinking habits (categorical; current, former or never), physical activity (continuous, times/a week) and body weight (continuous, kg).

All statistical tests were based on two-sided probabilities and were performed using SPSS version 25.0J for Windows (IBM Inc., Japan, Tokyo Japan). All p values <0.05 were considered statistically significant.

RESULTS

Characteristics of the participants

Table 1 shows the characteristics of the subjects by gender. The mean ages were 67.0±5.3 years in men and 66.6±5.0 years in women. The mean TMIG-IC scores

Table 1. Characteristics of subjects by gender

	Men (n=200)	Women (n=200)	p
Age (years)†	67.0±5.3	66.6±5.0	0.387
Body weight (kg)†	67.2±11.3	53.5±12.8	<0.001
Current physical activity (times/a week)†	2.7±2.9	2.4±2.7	0.334
Total TMIG-IC score†	10.3±2.1	11.0±1.9	<0.001
Education‡			
≤9 years	2 (1.0)	2 (1.0)	<0.001
9–12 years	52 (26.0)	71 (35.5)	
>12 years	146 (73.0)	127 (63.5)	
Annual household income‡			
<1.49 million yen	16 (8.0)	16 (8.0)	0.716
1.50 - 5.49 million yen	81 (40.5)	84 (42.0)	
>5.50 million yen	81 (40.5)	72 (36.0)	
Unknown	22 (11.0)	28 (14.0)	
Living alone‡	30 (15.0)	34 (17.0)	0.341
Smoking habit‡			
Current	66 (33.0)	16 (8.0)	<0.001
Former	86 (43.0)	33 (16.5)	
Never	48 (24.0)	151 (75.5)	
Drinking habit‡			
Current	159 (79.5)	97 (48.5)	<0.001
Former	19 (9.5)	15 (7.5)	
Never	22 (11.0)	88 (44.0)	
Self-rated health‡			
Very good	10 (5.0)	11 (5.5)	0.824
Good	55 (27.5)	64 (32.0)	
Normal	113 (56.5)	108 (54.0)	
Poor	21 (10.5)	16 (8.0)	
Very poor	1 (0.5)	1 (0.5)	

†Mean±SD. ‡Number (%).

were 10.3±2.1 in men and 11.0±1.9 years in women. The proportions of participants with a total TMIG-IC score >10 were 74.5 % in men and 92.0 % in women. The proportions of participants with a more than normal condition in self-related health were 89.0 % in men and 91.5 % in women.

Differences in food choice motives before and during the COVID-19 pandemic

Table 2 shows the differences in food choice motives before and during the COVID-19 pandemic. Out of 9 food choice motives, scores for the importance of weight control (-0.28±0.98, $p<0.001$ in men; -0.30±1.14, $p<0.001$ in women), physical well-being (-0.28±1.13, $p=0.001$ in men; -0.53±1.31, $p<0.001$ in women) and economical efficiency (-0.18±1.07, $p=0.018$ in men; -0.52±1.24, $p<0.001$ in women) significantly increased in both sexes.

Differences in intake of food groups and dietary behaviors before and during the COVID-19 pandemic

Table 3 shows comparisons of intake of food groups and dietary behaviors before and during the COVID-19 pandemic. In both men and women, the frequency of intake of deep yellow vegetables was lower during the COVID-19 pandemic than that before the pandemic (-0.18±1.17, $p=0.034$ in men, -0.23±1.31, $p=0.015$ in women). DVS was lower during the COVID-19 pandemic than that before the pandemic (-0.13±0.78, $p=0.019$) in women, but there was no difference in men.

In both men and women, frequency of eating out was lower during the COVID-19 pandemic than that before the pandemic (-0.28±1.02, $p<0.001$ in men, -0.27±1.17, $p=0.002$ in women). The frequency of self-cooking meals was higher during the COVID-19 pandemic than that the before pandemic (-0.58±2.22, $p<0.001$) in women but not in men.

Associations of food choice motives, dietary diversity and dietary behaviors with COVID-19 pandemic

Table 4 shows the associations of food choice motives, dietary diversity and dietary behaviors with COVID-19 pandemic. In the multivariate adjustment model, physical well-being and economical efficiency were shown to have significant positive associations with the COVID-19 pandemic in women ($p=0.034$ and 0.009, respectively). In contrast, eating out was shown to have a significant inverse association with the COVID-19 pandemic in women ($p=0.009$).

These results did not change substantially after excluding participants with a total TMIG-IC score ≤10 (data not shown).

DISCUSSION

In the present study, it was shown that 'quality clarity', 'weight control', 'physical well-being', 'convenience of cooking' and 'economical efficiency' as food choice motives became important in men and that 'sensory/mood', 'weight control', 'physical well-being' and 'economical efficiency' as food choice motives became important in women during the COVID-19 pandemic. In a previous cross-sectional study in 1,232 Croatian adults aged 18-87 years, it was shown that 'natural content', 'health', 'convenience', 'price', 'weight control', 'familiarity', and 'ethical concern' became more important for women and that 'price', 'weight control', 'familiarity', and 'ethical concern' became more important for men during the COVID-19 pandemic.[22] In another study conducted in 938 adults aged over 18 years in France, many participants stated that 'mood', 'health' and 'weight control' were more important during the period of the COVID-19 pandemic, while half of the participants stated that 'convenience' was less important.[15] In addition, among 2,448 Polish adolescents aged 15-20 years old, 'health' and 'weight control' for women and 'weight control' for men were more important during the period of COVID-19 pandemic than before the pandemic, but 'mood' and 'sensory appeal' were less important during the pandemic in both sexes.[23] The COVID-19 pandemic affected the importance of 'economy' for women in our study and the importance of 'health/weight control', which was shown to have significantly increased in both our study and the above-mentioned studies. Since there were differences about the FCQ used for research (e.g., the number of FCQ items and the age group for the FCQ) between the present study and some previous studies, consideration must be given to the above points when interpreting the results. However, it is possible that the period of the COVID-19 pandemic had some effects on food choice motives. Actually, the frequency of going out during the period of the COVID-19 pandemic decreased in female participants in the present study (4.8±3.3 times a week before the COVID-19 pandemic vs. 3.8±2.6 times a week during the period of the COVID-19 pandemic, $p<0.001$). In addition, the frequency of eating out during the COVID-19 pandemic decreased in the female participants (0.7±0.9 times a week before the COVID-19 pandemic vs. 0.4±1.1 times a week during the COVID-19 pandemic, $p=0.002$), while the frequency of self-catering during the COVID-19 pandemic increased in the female participants (9.8±8.6 times a week before the COVID-19 pandemic vs. 10.4±8.8 times a week during the COVID-19 pandemic, $p<0.001$). The participants in this study increased their frequency of self-catering and tended to buy items that can be stockpiled and items that can be easily cooked while, at the same time, reducing their frequency of going out including going out for grocery shopping and for eating out. In this situation, they might have come to select ingredients with an emphasis on easiness of cooking.

In our study, there was no significant association between the COVID-19 pandemic and dietary diversity, but the COVID-19 pandemic was associated with eating out after controlling for various confounding factors. In previous study, the nutritional quality of the diet was decreased during the COVID-19 lockdown in France by increasing the intake of processed meat, sugary food, sweet-tasting beverages and alcoholic beverages.[15] On the other hand, it has been reported that diet quality was improved by increasing the intake of whole cereals, vegetables including plant proteins, beans and fish in Canadian adults during the early COVID-19–related lockdown.[24] In a study conducted in Canadian adults, the frequency of eating out was shown to decrease during the early COVID-19–related lockdown.[24] Thus, a lockdown due to

Table 2. Comparison of food choice motives before and during the COVID-19 pandemic

	Before lockdown	During lockdown	Difference during vs. before	$p^{\ddagger}$	Increased during vs. before[§]	Unchanged during vs. before[¶]	Decreased during vs. before[††]
	Mean (SD)	Mean (SD)	Mean (SD)		n (%)	n (%)	n (%)
Men							
Sensory/mood (score)[†]	8.67 (2.17)	8.56 (2.19)	0.11 (0.98)	0.114	27 (13.5)	137 (68.5)	36 (18.0)
Quality clarity (score)[†]	9.93 (2.43)	10.1 (2.60)	-0.17 (1.20)	0.041	42 (21.0)	133 (66.5)	25 (12.5)
Weight control (score)[†]	7.80 (2.23)	8.08 (2.48)	-0.28 (0.89)	<0.001	52 (26.0)	132 (66.0)	16 (8.0)
Physical well-being (score)[†]	8.75 (2.68)	9.02 (2.75)	-0.28 (1.13)	0.001	53 (26.5)	125 (62.5)	22 (11.0)
Nutrition balance (score)[†]	9.90 (2.57)	9.97 (2.61)	-0.06 (1.07)	0.390	38 (19.0)	130 (65.0)	32 (16.0)
Convenience of cooking (score)[†]	8.95 (2.55)	9.11 (2.58)	-0.16 (1.04)	0.026	39 (19.5)	143 (71.5)	18 (9.0)
Familiarity (score)[†]	9.19 (2.24)	9.22 (2.44)	-0.04 (1.00)	0.623	27 (13.5)	141 (70.5)	32 (16.0)
Relationship with others (score)[†]	6.77 (2.23)	6.87 (2.43)	-0.10 (0.92)	0.125	25 (12.5)	156 (78.0)	19 (9.5)
Economical efficiency (score)[†]	9.54 (2.47)	9.72 (2.52)	-0.18 (1.07)	0.018	44 (22.0)	126 (63.0)	30 (15.0)
Women							
Sensory/mood (score)[†]	9.07 (2.28)	9.30 (2.62)	-0.23 (1.26)	0.011	59 (29.5)	107 (53.5)	34 (17.0)
Quality clarity (score)[†]	11.4 (2.46)	11.4 (2.43)	-0.08 (1.27)	0.372	44 (22.0)	120 (60.0)	36 (18.0)
Weight control (score)[†]	8.49 (2.26)	8.79 (2.37)	-0.30 (1.14)	<0.001	63 (31.5)	101 (50.5)	36 (18.0)
Physical well-being (score)[†]	9.73 (2.64)	10.3 (2.80)	-0.53 (1.31)	<0.001	78 (39.0)	95 (47.5)	27 (13.5)
Nutrition balance (score)[†]	11.5 (2.25)	11.5 (2.14)	-0.06 (1.03)	0.374	50 (25.0)	105 (52.5)	45 (22.5)
Convenience of cooking (score)[†]	9.94 (2.67)	10.1 (2.90)	-0.18 (1.32)	0.062	58 (29.0)	107 (53.5)	35 (17.5)
Familiarity (score)[†]	10.2 (2.33)	10.3 (2.35)	-0.03 (1.24)	0.775	41 (20.5)	116 (58.0)	43 (21.5)
Relationship with others (score)[†]	7.49 (2.36)	7.58 (2.63)	-0.09 (1.27)	0.319	37 (18.5)	128 (64.0)	35 (17.5)
Economical efficiency (score)[†]	11.1 (2.06)	11.6 (2.15)	-0.52 (1.24)	<0.001	77 (38.5)	106 (53.0)	17 (8.5)

[†]Score range: 3 to 15.
[‡]Paired t-test was used.
[§]Corresponds to participants with Δ motives >0.
[¶]Corresponds to participants with Δ motives =0.
[††]Corresponds to participants with Δ motives <0.

Table 3. Comparison of dietary diversity and frequency of dietary behaviors before and during the COVID-19 pandemic

	Before lockdown	During lockdown	Difference during vs. before	$p^{\ddagger}$	Increased during vs. before[§]	Unchanged during vs. before[¶]	Decreased during vs. before[††]
	Mean (SD)	Mean (SD)	Mean (SD)		n (%)	n (%)	n (%)
Men							
Dietary variety score (score)[†]	2.13 (2.00)	2.13 (2.05)	-0.01 (0.59)	0.812	18 (9.00)	164 (82.0)	18 (9.00)
Fish and shellfish (times / week)	2.67 (1.96)	2.73 (1.99)	0.07 (0.64)	0.144	5 (2.50)	186 (93.0)	9 (4.50)
Meat (times / week)	3.05 (1.86)	3.07 (1.86)	0.02 (0.60)	0.704	7 (3.50)	185 (92.5)	8 (4.00)
Eggs (times / week)	3.70 (2.36)	3.71 (2.32)	0.01 (0.86)	0.886	9 (4.50)	180 (90.0)	11 (5.50)
Milk and dairy products (times / week)	3.57 (3.06)	3.63 (3.04)	0.06 (0.64)	0.198	2 (1.00)	192 (96.0)	6 (3.00)
Soy and soy products (times / week)	3.35 (2.30)	3.31 (2.27)	-0.04 (1.02)	0.581	13 (6.50)	175 (87.5)	12 (6.00)
Deep yellow vegetables (times / week)	4.14 (2.42)	3.96 (2.53)	-0.18 (1.17)	0.034	23 (11.5)	169 (84.5)	8 (4.00)
Seaweed (times / week)	2.44 (2.09)	2.43 (2.08)	-0.01 (0.92)	0.908	13 (6.50)	175 (87.5)	12 (6.00)
Potatoes (times / week)	1.85 (1.51)	1.91 (1.54)	0.06 (0.64)	0.179	6 (3.00)	183 (91.5)	11 (5.50)
Fruits (times / week)	2.96 (2.62)	3.04 (2.59)	0.08 (0.98)	0.252	10 (5.00)	173 (86.5)	17 (8.50)
Fats and oil (times / week)	2.98 (2.06)	3.08 (2.08)	0.10 (1.04)	0.166	11 (5.50)	171 (85.5)	18 (9.00)
Self-cooking meal (times / week)	7.50 (5.83)	7.46 (5.63)	-0.04 (2.96)	0.849	29 (14.5)	154 (77.0)	17 (8.50)
Eating out (times / week)	1.10 (1.85)	0.82 (1.81)	-0.28 (1.02)	<0.001	12 (6.00)	134 (67.0)	54 (27.0)
Snacks (times / week)	1.58 (2.64)	1.50 (2.56)	-0.08 (1.08)	0.295	15 (7.50)	169 (84.5)	16 (8.00)
Skipping meals (times / week)	0.44 (1.48)	0.46 (1.48)	0.02 (0.39)	0.591	8 (4.00)	186 (93.0)	6 (3.00)
Eating alone (times / week)	4.18 (5.50)	4.10 (5.53)	-0.08 (1.16)	0.331	12 (6.00)	172 (86.0)	16 (8.00)
Use of supplements (times / week)	2.21 (3.65)	2.45 (4.01)	0.24 (1.80)	0.061	9 (4.50)	188 (94.0)	3 (1.50)
Women							
Dietary variety score (score)[†]	3.80 (2.32)	3.67 (2.41)	-0.13 (0.78)	0.019	22 (11.0)	143 (71.5)	35 (17.5)
Fish and shellfish (times / week)	2.92 (2.05)	2.93 (1.96)	0.01 (0.77)	0.854	9 (4.50)	179 (89.5)	12 (6.00)
Meat (times / week)	3.71 (2.19)	3.72 (2.08)	0.02 (1.03)	0.837	12 (6.00)	172 (86.0)	16 (8.00)
Eggs (times / week)	4.37 (2.38)	4.40 (2.35)	0.03 (1.00)	0.633	8 (4.00)	182 (91.0)	10 (5.00)
Milk and dairy products (times / week)	4.71 (2.93)	4.71 (2.92)	0.00 (0.68)	0.979	5 (2.50)	189 (94.5)	6 (3.00)
Soy and soy products (times / week)	4.60 (2.49)	4.52 (2.42)	-0.08 (0.99)	0.241	11 (5.50)	180 (90.0)	9 (4.50)
Deep yellow vegetables (times / week)	5.59 (2.17)	5.36 (2.19)	-0.23 (1.31)	0.015	18 (9.00)	177 (88.5)	5 (2.50)
Seaweed (times / week)	3.10 (2.35)	3.06 (2.35)	-0.04 (1.22)	0.634	22 (11.0)	161 (80.5)	17 (8.50)
Potatoes (times / week)	2.32 (1.94)	2.30 (1.92)	-0.02 (1.05)	0.748	14 (7.00)	173 (86.5)	13 (6.50)
Fruits (times / week)	4.44 (2.62)	4.42 (2.63)	-0.02 (1.34)	0.823	14 (7.00)	168 (84.0)	18 (9.00)
Fats and oil (times / week)	4.38 (2.39)	4.34 (2.49)	-0.03 (1.10)	0.677	16 (8.00)	174 (87.0)	10 (5.00)
Self-cooking meal (times / week)	9.82 (8.59)	10.4 (8.75)	0.58 (2.22)	<0.001	37 (18.5)	158 (79.0)	5 (2.50)
Eating out (times / week)	0.70 (0.88)	0.44 (1.10)	-0.27 (1.17)	0.002	8 (4.00)	123 (61.5)	69 (34.5)
Snacks (times / week)	3.10 (3.48)	3.16 (3.42)	0.06 (1.59)	0.565	22 (11.0)	160 (80.0)	18 (9.00)
Skipping meals (times / week)	0.36 (1.27)	0.45 (1.63)	0.09 (1.18)	0.308	8 (4.00)	184 (92.0)	8 (4.00)
Eating alone (times / week)	3.92 (5.40)	3.87 (5.61)	-0.05 (1.40)	0.579	11 (5.50)	167 (83.5)	22 (11.0)
Use of supplements (times / week)	2.96 (3.69)	3.00 (3.67)	0.04 (0.67)	0.459	9 (4.50)	188 (94.0)	3 (1.50)

[†]Score range: 0 to 10. Higher dietary variety score means higher dietary diversity.
[‡]Paired t-test was used.
[§]Corresponds to participants with Δ motives >0.
[¶]Corresponds to participants with Δ motives =0.
[††]Corresponds to participants with Δ motives <0.

Table 4. Food choice motives, dietary intake and frequency of dietary behaviors before and during the COVID-19 pandemic[†]

	Age-adjusted model [‡]		*p*	Multivariable-adjusted model [§¶]		*p*
	Before lockdown	During lockdown		Before lockdown	During lockdown	
	Mean (95% CI)	Mean (95% CI)		Mean (95% CI)	Mean (95% CI)	
Men						
Sensory/mood (score)	8.67 (8.36-8.97)	8.56 (8.25-8.86)	0.614	8.67 (8.37-8.96)	8.55 (8.26-8.85)	0.595
Quality clarity (score)	9.93 (9.57-10.3)	10.1 (9.75-10.5)	0.488	9.93 (9.58-10.3)	10.1 (9.75-10.4)	0.489
Weight control (score)	7.80 (7.47-8.13)	8.08 (7.75-8.41)	0.234	7.80 (7.49-8.12)	8.08 (7.76-8.39)	0.223
Physical well-being (score)	8.75 (8.37-9.12)	9.02 (8.65-9.39)	0.304	8.75 (8.38-9.11)	9.02 (8.65-9.39)	0.306
Nutrition balance (score)	9.90 (9.54-10.3)	9.97 (9.61-10.3)	0.799	9.90 (9.55-10.3)	9.96 (9.61-10.3)	0.808
Convenience of cooking (score)	8.95 (8.59-9.30)	9.11 (8.75-9.47)	0.521	8.95 (8.60-9.29)	9.11 (8.76-9.46)	0.514
Familiarity (score)	9.19 (8.86-9.51)	9.22 (8.90-9.54)	0.880	9.19 (8.87-9.50)	9.22 (8.90-9.54)	0.888
Relationship with others (score)	6.77 (6.44-7.09)	6.87 (6.54-7.19)	0.668	6.77 (6.45-7.09)	6.86 (6.54-7.18)	0.675
Economical efficiency (score)	9.54 (9.19-9.88)	9.72 (9.37-10.1)	0.467	9.54 (9.20-9.88)	9.71 (9.37-10.1)	0.471
Dietary variety score (score)	2.14 (1.87-2.41)	2.13 (1.86-2.40)	0.959	2.14 (1.89-2.39)	2.12 (1.87-2.37)	0.934
Self-cooking meal (times / week)	7.50 (6.70-8.29)	7.46 (6.66-8.25)	0.944	7.50 (6.71-8.29)	7.45 (6.66-8.25)	0.939
Eating out (times / week)	1.10 (0.84-1.35)	0.82 (0.57-1.07)	0.132	1.10 (0.85-1.35)	0.82 (0.57-1.07)	0.127
Snacks (times / week)	1.58 (1.21-1.94)	1.50 (1.13-1.86)	0.759	1.58 (1.22-1.93)	1.50 (1.14-1.85)	0.754
Skipping meals (times / week)	0.44 (0.23-0.65)	0.46 (1.25-1.66)	0.919	0.44 (0.24-0.64)	0.46 (0.25-0.66)	0.918
Eating alone (times / week)	4.18 (3.43-4.92)	4.10 (3.35-4.84)	0.882	4.18 (3.51-4.84)	4.10 (3.43-4.76)	0.869
Use of supplements (times / week)	2.21 (1.68-2.74)	2.45 (1.19-2.98)	0.532	2.21 (1.68-2.74)	2.45 (1.92-2.98)	0.535
Women						
Sensory/mood (score)	9.07 (8.73-9.41)	9.30 (8.96-9.64)	0.346	9.07 (8.73-9.41)	9.30 (8.96-9.64)	0.343
Quality clarity (score)	11.4 (11.0-11.7)	11.4 (11.1-11.8)	0.742	11.3 (11.0-11.7)	11.4 (11.1-11.8)	0.690
Weight control (score)	8.49 (8.17-8.81)	8.79 (8.47-9.11)	0.193	8.48 (8.17-8.79)	8.80 (8.49-9.11)	0.150
Physical well-being (score)	9.73 (9.36-10.1)	10.3 (9.88-10.6)	0.051	9.71 (9.35-10.1)	10.3 (9.91-10.6)	0.034
Nutrition balance (score)	11.5 (11.2-11.8)	11.5 (11.2-11.8)	0.764	11.4 (11.2-11.7)	11.5 (11.3-11.8)	0.641
Convenience of cooking (score)	9.94 (9.56-10.3)	10.1 (9.73-10.5)	0.527	9.93 (9.56-10.3)	10.1 (9.74-10.5)	0.492
Familiarity (score)	10.2 (9.90-10.6)	10.3 (9.92-10.6)	0.915	10.2 (9.89-10.5)	10.3 (9.93-10.6)	0.853
Relationship with others (score)	7.49 (7.14-7.84)	7.58 (7.23-7.93)	0.718	7.48 (7.14-7.82)	7.59 (7.25-7.93)	0.672
Economical efficiency (score)	11.1 (10.8-11.4)	11.6 (11.3-11.9)	0.014	11.1 (10.8-11.4)	11.6 (11.3-11.9)	0.009
Dietary variety score (score)	3.80 (3.47-4.12)	3.67 (3.34-3.99)	0.578	3.77 (3.46-4.08)	3.69 (3.38-4.00)	0.720
Self-cooking meal (times / week)	9.82 (8.61-11.0)	10.4 (9.19-11.6)	0.506	9.81 (8.62-11.0)	10.4 (9.21-11.6)	0.492
Eating out (times / week)	0.70 (0.56-0.84)	0.44 (0.30-0.57)	0.008	0.70 (0.56-0.84)	0.44 (0.30-0.58)	0.009
Snacks (times / week)	3.10 (2.62-3.57)	3.16 (2.68-3.64)	0.850	3.09 (2.62-3.56)	3.17 (2.70-3.64)	0.817
Skipping meals (times / week)	0.36 (1.16-1.56)	0.45 (1.24-1.65)	0.561	0.36 (0.16-0.56)	0.45 (0.25-0.65)	0.526
Eating alone (times / week)	3.92 (3.15-4.69)	3.87 (3.10-4.63)	0.921	3.92 (3.34-4.50)	3.87 (3.28-4.45)	0.899
Use of supplements (times / week)	2.96 (2.45-3.47)	3.00 (2.48-3.51)	0.924	2.95 (2.45-3.45)	3.00 (2.50-3.50)	0.887

[†]Adjusted mean (95% confidence interval).
[‡]Age-adjusted general linear model was used. Independent variables were food choice motives, dietary intake or frequency of dietary behaviors. The dependent variable was groups depending on before and during the COVID-19 pandemic.
[§]Multivariable-adjusted general linear model was used. Independent variables were food choice motives, dietary intake or frequency of dietary behaviors. The dependent variable was groups depending on before and during the COVID-19 pandemic.
[¶]Adjusted for age, area, living status, education level, annual household income, smoking habit, drinking habit, physical activity and body weight.

COVID-19 might have affected dietary habits through changes in eating behaviors such as eating out. However, since we could not collect data for detailed amounts of dietary intake, we cannot discuss this point. In addition, the differences in these results might be caused by differences in study populations, dietary habits of the subjects, dietary assessment methods, and study design.

We found that were sex differences in the associations of lockdown due to the COVID-19 pandemic with food choice motives and eating out in the present study. One reason for those differences might be related to the awareness of division of roles by gender that elderly Japanese have. Most elderly Japanese people have the thinking value that 'men work and women do household chores'.[25] Women spend much more time than men do for housework including cooking after marriage in Japan.[26,27] Furthermore, it has been reported that women tend to make healthy food choices and/or have healthy dietary behavior compared to those for men.[28,29] In a Finnish population aged 18-65 years, it was reported that women were more interested in than were men and reported much more active seeking of health-related information than did men, that women paid more attention to potential worldwide pandemics (such as bovine spongiform encephalopathy and bird flu) than did men and that women were much more attentive as to how the goods they purchase in everyday life affect their health than were men.[30] Our results might mean that a lockdown due to the COVID-19 pandemic affected food choice motives and/or dietary behaviors more strongly in women than in men.

The present study is first study to clarify how food choice motives and dietary habits changed during the COVID-19 pandemic in healthy elderly Japanese. However, our study has several limitations. First, the results of the cross-sectional analyses are not sufficient for debating whether there are cause-and-effect relationships of food choice motives and dietary habits with a lockdown due to COVID-19. Second, there is a possibility that a sample error occurred because we conducted an Internet panel survey. Participants were recruited from a population registered with ASMARQ Co., Ltd. and were individuals who agreed to participate in a study exploring dietary behavior. Therefore, it is possible that the subjects of this study were biased toward individuals who were interested in food and dietary behaviors. The proportion of elderly people in this study who had an educational background of university graduation or higher was 48.8%. It is possible that the population in this study is more highly educated than the general population of the same age group. These populations might be more health conscious than the general elderly population.[31] Third, since we could not assess cognitive function, it is unclear whether the participants had sufficient ability to remember what they were eating. However, out of TMIG-IC scores, the score for intellectual activity related to cognitive function[32] did not change in the participants during the COVID-19 pandemic (score of 3.41±0.89 before the COVID-19 pandemic vs. score of 3.42±0.89 during the COVID-19 pandemic, $p<0.001$). On the other hand, out of TMIG-IC scores, the score for social role including going shopping and/or meeting others decreased in the participants during the COVID-19 pandemic (score of 3.07±1.20 before the COVID-19 pandemic vs. score of 2.38±1.39 during the COVID-19 pandemic, $p<0.001$). These results might indicate that cognitive abilities reflected by intellectual activity were maintained, although the score for social roles reflects less involvement with friends and family. Fourth, although we collected only the frequencies of intake of the following 10 food groups (fish and shellfish, meats, eggs, dairy, legumes, deep yellow vegetables, potatoes, and oil and fats), we could not collect detail dietary intake such as traditional Japanese food intake (e.g., miso soup, tofu, fermented soy, beverages, raw versus cooked foods). Therefore, we could not assess the association between detail food intake and COVID-19 pandemic in this study. Fifth, we could not assess the association between food choice motives depending anti-inflammatory of foods and COVID-19 pandemic in present study. During the COVID-19 pandemic, it is expected that many people were interested in the link between diet and infection. Since the FCQ-E used in our study contains an 'physical well-being', it might be possible that the subject's response reflects 'food selection with the expectation of anti-inflammatory effects of food'. However, since it is not the questionnaire that specifically considers the anti-inflammatory effect, it may not be possible to fully evaluate this point. Finally, the relationships of food choice motives and dietary habits with the COVID-19 pandemic were robust after controlling for various confounders. However, there may have been other confounding factors that were not completely eliminated, although various potentially important confounders were controlled during the analyses. Food selection is determined by the mutual influence of complex factors.[33] Therefore, various other factors, such as food availability, may have influenced people's food choice of what to eat during the COVID-19 pandemic.

In conclusion, our results indicate the possibility that there were changes in food choice motives and dietary habits after the declaration of a nationwide state of emergency due to the COVID-19 pandemic compared to those before the pandemic among healthy elderly Japanese.

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AUTHOR DISCLOSURES

All authors state that they have no conflicts of interest.

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Supplemental table 1. Population composition ratio[†‡]

	Men		Women	
	Present study	National	Present study	National
Hokkaido	11 (5.5)	770,021 (4.4)	9 (4.5)	946,224 (4.8)
Tohoku	5 (2.5)	1,329,830 (7.7)	12 (6.0)	1,524,448 (7.7)
Kanto	100 (50.0)	5,595,586 (32.3)	99 (49.5)	6,197,292 (31.3)
Chubu	18 (9.0)	2,977,781 (17.2)	16 (8.0)	3,331,333 (16.8)
Kansai	36 (18.0)	3,018,525 (17.4)	45 (22.5)	3,535,658 (17.9)
Chugoku/ Shikoku	15 (7.5)	1,623,925 (9.4)	12 (6.0)	1,887,543 (9.5)
Kyushu	15 (7.5)	2,007,020 (11.6)	7 (3.5)	2,348,801 (11.9)
Total	200 (100)	17,322,688 (100)	200 (100)	19,771,299 (100)

[†]Number (%).
[‡]The national data were based on "Basic Resident Registration by Age and Prefecture on January 1, 2021".

Supplemental table 2. Food choice questionnaire for the elderly in Japan[†]

Factors of food choice motives	Subfactors
Factor 1 - Sensory / mood	Makes my mouth refreshed
	Has a pleasant texture
	Tastes good
Factor 2 - Quality clarity	Is clear the brand and quality
	Is clear the manufacturer
	Is clear the date of manufacture
Factor 3 - Weight control	Is low in calories
	Is low in sugar
	Is high in calories
Factor 4 - Physical well-being	Recover from fatigue
	Improve blood flow
	Warm the body
Factor 5 - Nutrition balance	Is nutritious
	Eat various kinds of foods
	Make up for lack of nutrition
Factor 6 - Convenience of cooking	Takes no time to prepare
	Is easy to prepare
	Can be cooked very simply
Factor 7 - Familiarity	Is familiar
	Is like the food I ate when I was a child
	Is what I usually eat
Factor 8 - Relationship with others	Is recommended by an acquaintance
	Is recommended by shop staffs
	Is the one that many acquaintance choose
Factor 9 - Economical efficiency	Can be used up
	Think not to waste foods
	Is food with a wide range of use

[†]The participants were asked to endorse the statement 'How important is each of the following 9 factors when choosing foods?' for each of the 9 factors (27 sub factors) items by choosing between five responses: not at all important, not very important, a little important, moderately important and very important, scored 1 to 5.