

Original Article

Relationship between food security and dietary habits and subjective sense of health and subjective sense of well-being among residents of large-scale housing complexes in Japan

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Abstract

Background: This study aimed to determine the relationship between food security and dietary habits and subjective health and subjective well-being among residents of a large-scale housing complex in Japan. **Methods:** This study used a cross-sectional design through a self-administered questionnaire survey. The study subjects were residents of Mukogawa Danchi in Nishinomiya City, Hyogo Prefecture, Japan, and data from 515 households out of 6,857 total dwelling units were used for the analysis. Food security status (HFSSM), dietary diversity score (HDDS), diet, eating behavior, subjective sense of health, and subjective sense of well-being were examined using logistic regression analysis. **Results:** Food insecurity was negatively associated with household dietary diversity scores (OR [95%CI]:0.49 [0.24–0.98] $p = 0.044$). Similarly, food insecurity was negatively associated with having a nutritionally balanced diet and having a satisfactory amount of food. There was also a negative association with family meals. There was a negative association between food insecurity and a subjective sense of health and a negative association (0.35 [0.15–0.78] $p = 0.011$) with a subjective sense of well-being among those aged 65 and older. **Conclusions:** In a large-scale housing complex in Japan, inadequate dietary intake was observed in food-insecure households; they ate meals less frequently with their families. Additionally, residents experiencing food insecurity tended to have lower subjective health and subjective well-being, depending on their age.

Keywords: food security, dietary quality, eating behavior, self-rated health

Introduction

During Japan's postwar period of rapid economic growth, many housing complexes were built as a national policy to cope with the population concentration in metropolitan areas. Currently, more than 50 years after their development, these housing complexes are experiencing a significant outflow of the population to other areas and an aging population, and the vitality of local communities is declining¹⁾.

There are many such housing complexes in Japan, and the national and local governments are collaborating with various entities to promote the revitalization of regional housing complexes²⁾. The consideration of the perspective of community development that enhances the residents' subjective sense of health and happiness is important for this revitalization strategy. In these large-scale housing complexes, local governments and the Urban Renaissance Agency, which operate public housing, offer preferential rent and other measures to attract younger generations with lower incomes and foreign residents^{3–5)}. Therefore, some older housing complexes have a high percentage of residents with relatively low incomes. Recently, health and nutritional intake problems have been reported among residents of such housing complexes, and it has been determined that these problems are related to household income⁶⁾.

Thus, we focused on the concept of food security, which evaluates social and economic poverty regarding diet⁷⁾. Food insecurity is defined as limited or uncertain access to nutritionally adequate and safe food⁸⁾. The U.S. Department of Agriculture (USDA) has developed a household food-security survey module to evaluate food security at the household level⁹⁾.

The National Health and Nutrition Examination Surveys of the United States, Canada, Australia, Portugal, South Korea, and other countries have introduced this scale, and revealed that decline in diet quality and insufficient food variety in households with food insecurity. The Surveys suggested that the food insecurity resulted in mental health problems^{10–12)}.

Recently, there have also been reports on the use of this scale to evaluate the outcomes of food assistance to poor households^{13,14)}. However, in Japan and many other Asian countries, there is no concept of assessing household-level economic poverty regarding diet; moreover, except for a few examples^{15,16)}, there are few reports on household food security. Hence, the knowledge of the actual situation of national food security and its related factors in these countries will provide new insights into the security measures for the livelihood of poor households.

The purpose of this study was to clarify the relationship between the actual state of food security in households in the aforementioned large-scale apartment complexes and their dietary situation, subjective health, and subjective sense of well-being. The significance of food aid is considered a strategy to help residents live better and restore the vitality of their communities.

Materials and Methods

Study design and participants

This study was a cross-sectional study using a self-administered questionnaire survey. The study was conducted in Mukogawa Danchi, Nishinomiya City, Hyogo Prefecture, which is located in the Osaka-Kobe metropolitan area and comprises a large-scale housing complex built in the 1970s. The housing has deteriorated over the past 50 years since its development, and the population is aging rapidly as the next generation moves out to other areas. Furthermore, poor households and immigrants are moving into the area in search of inexpensive housing.

The survey was administered to all residents of the Mukogawa housing complex, with one representative per household. An explanation of the purpose of the study and data handling was included at the beginning of the questionnaire, and written informed consent was obtained from all study participants. One copy of the questionnaire was distributed to each of the 6,857 households in the complex in late June 2023 and collected at a local commercial plaza in early July.

During the collection period, 602 copies of the questionnaire were submitted (collection rate: 8.8%). Of these, 87 respondents with missing items in the attributes and food security status were excluded from the analysis, and data for 515 respondents were used for the analysis (valid response rate: 85.5%).

The present study protocol was approved by the Ethics Committees of Mukogawa Women's University (23–24).

Measures

1) Assessment of food security status

Food security status—the primary independent variable in this research analysis—was assessed using a Japanese translation of the U.S. Household Food Security Survey Module: Six-Item Short Form¹⁷⁾. This scale was developed by the National Center for Health Statistics as an abridged version based on the 18-item U.S. Household Food Security Survey Module, which has minimal bias compared to the 18-item measure and is recognized for its utility. In this study, food security status was defined as food security according to the USDA Six-Item Short Form of the Food Security Survey Module User Note¹⁸⁾. Food security status was divided into two categories: food security (high or marginal food security) and food insecurity (low food security and extremely low food security).

2) Dietary intake status

The household's dietary intake was evaluated according to three perspectives.

Household dietary diversity

Household dietary diversity was assessed through a checklist of 12 food groups proposed by Food and Agriculture Organization¹⁹⁾. The scores are a continuous 12-point scale calculated by adding up the number of food groups consumed by household members in the past 24 hours at the time of the response. The 12 food groups are staple foods (rice, cereals), tubers/roots, vegetables, fruits, fish (including dried fish and seafood), meat (including poultry), eggs, nuts and seeds, and milk (all based on the HDDS guide)²⁰⁾, foods marketed in Japan and consumed daily were included in the food groups. The median score in this study was 10, and the subjects were divided into two categories: 11–12 points for the good group and 0–10 points for the poor group.

Meal contents/details

The following questions were asked: whether fresh fruits and vegetables were included in the diet, whether the diet was nutritionally balanced, and whether the diet contained a satisfactory amount of nutrients. The median value of the answers was used as a reference to divide the respondents into two categories: “always” as the “good” group and “sometimes,” “occasionally,” and “hardly ever” as the “bad” group.

Dietary self-assessment

A question was asked about whether people thought about the need to improve their own and their family's eating habits.

3) Eating habits/behavior

In setting up the questionnaire items to evaluate eating behavior, we referred to the Fourth Basic Plan for the Promotion of Nutrition Education issued by the Cabinet Office²¹⁾. Responses to each question were divided into two groups based on the median value. The frequency of use of instant foods, frozen foods, retort pouch foods, and canned foods at home was defined as “rarely” or “1–4 times a month” for the “low use” group and “2–4 times a week” or “5 times a week or more” for the “high use” group. The “Yes” group was defined as “always refer to” or “refer to” the information on ingredients and nutritional value listed on food packages, and the “No” group was defined as “do not refer to” or “do not refer to very much.” The frequency of eating breakfast and dinner together as a family was defined as “every day,” “5–6 days,” “3–4 days,” “1–2 days,” and “rarely” as “many,” respectively. Additionally, a question asking whether family members missed breakfast was included.

4) Primary outcome

The primary outcomes in this research analysis were subjective health and subjective well-being, which were assessed using the following questions: “How is your current state of health?” and “How happy are you now?” This questionnaire was developed by the Ministry of Health, Labour and Welfare (MHLW) and is based on the National Survey on Quality of Life conducted by the MHLW and the Cabinet Office. The respondents were asked to self-evaluate these questions using a 10-point Likert scale, where “very healthy” and “very happy” were set to 10 and “very unhealthy” and “very unhappy” to 1, respectively. The median value of the subjective sense of health and that of well-being was 7, and they were divided into two categories: 1–6 as the poor group and 7–10 as the good group.

5) Demographic covariates

Other variables included age, gender, nationality (Japan/Other), length of residence, number of family members, and presence of children aged under 17 years. Income was categorized into “less than 2 million yen,” “2–6 million yen,” and “more than 6 million yen.” Subjective financial comfort was examined in the following categories: “I have sufficient money, and I am not worried at all,” “I do not have sufficient money, but I am not so worried,” “I do not have sufficient money, and I am somewhat worried,” and “I am extremely worried because my life is difficult.”

Statistical analysis

1) Demographics of the sample by food security status

The characteristics of the study participants are presented as a percentage of the number of participants for each attribute variable. A chi-square test was used to test the independence of the food security and food insecurity groups.

2) Association between food intake status, eating behavior, and food insecurity

The relationship between dietary intake status and food insecurity was examined using logistic regression analysis to obtain odds ratios and 95% confidence intervals for five items: HDDS categorized as binary, vegetable and fruit intake, nutritionally balanced dietary intake, satisfactory dietary intake, and dietary self-assessment. Food security status was used as the independent variable. The reference groups for the dependent variable were the good group and the need for improvement group. Model 1 was unadjusted, and Model 2 included age, gender, nationality, number of family members, length of residence, presence of children, and subjective financial comfort with life as adjustment variables. All these variables were entered using the forced entry method. Missing values were excluded each time. As income and subjective financial comfort were strongly related, the correlation between income and the dependent variable was examined beforehand, and subjective financial comfort, which was more strongly related, was adopted.

The relationship between eating behavior and food insecurity was also examined using logistic regression analysis. We used the following binary categorized five items, which are (1) using convenience foods, (2) referring to food information, (3) eating breakfast together, (4) eating dinner together, and (5) missing breakfast for a family member, as dependent variables. Food security status was used as an independent variable. The reference groups for the dependent variables were the high frequency of use group, the reference group, the high frequency of eating together group, and the missing breakfast group.

3) Association between self-rated health, self-rated well-being, and food insecurity

The relationship among subjective health, subjective well-being, and food insecurity was examined through age and gender using logistic regression analysis, and odds ratios and 95% confidence intervals were calculated. Food security status was used as the independent variable. The reference group for the dependent variable was the good group. Model 1 was unadjusted, Model 2 included age, gender, nationality, number of family members, length of residence, and presence of children as adjustment variables, and Model 3 included subjective financial comfort as an adjustment variable. All these variables were entered using the forced entry method. Missing values were excluded each time. The age category was divided into two groups: those aged 65 or older and those aged 64 or younger, the age at which pension benefits begin to accrue under the Japanese pension system.

Statistical analysis was performed using IBM SPSS Statistics 24 (IBM Corp., Armonk, NY, USA) with a statistical significance level of 5% (two-tailed test).

Results

Demographics of the sample by food security status

Table 1 presents the characteristics of all subjects and those categorized by food security status. Of the 515 subjects, 90 (17.5%) were food insecure. The attributes that differed significantly in the distribution of food security and food insecurity status were nationality, length of residence, presence of children, income, and subjective financial comfort.

Table 1. Demographics of the sample by food security status

Sample size	All 515	Food secure 425 (82.5)	Food insecure 90 (17.5)	<i>p</i> value
Age group				0.137
≤54	134 (26.0)	102 (24.0)	32 (35.6)	
55–64	82 (15.9)	70 (16.5)	12 (13.3)	
65–74	149 (28.9)	128 (30.1)	21 (23.3)	
75≤	150 (29.1)	125 (29.4)	25 (27.8)	
Gender				0.619
Male	164 (31.8)	133 (31.3)	31 (34.4)	
Female	351 (68.2)	292 (68.7)	59 (65.6)	
Nationality				0.000*
Japan	504 (97.9)	421 (99.1)	83 (92.2)	
Other	11 (2.1)	4 (0.9)	7 (7.8)	
Residence years				0.044*
–10	212 (41.2)	169 (39.8)	43 (47.8)	
11–30	169 (32.8)	136 (32.0)	33 (36.7)	
31–50	134 (26.0)	120 (28.2)	14 (15.6)	
Household size				0.090
1 member	169 (32.8)	135 (31.8)	34 (37.8)	
2–3 members	295 (57.3)	252 (59.3)	43 (47.8)	
4 or more members	51 (9.9)	38 (8.9)	13 (14.4)	
Households with children aged <17 years				0.020*
Applicable	73 (14.2)	53 (12.5)	20 (22.2)	
Not applicable	442 (85.8)	372 (87.5)	70 (77.8)	
Household income				0.000*
<200	101 (20.7)	71 (17.6)	30 (35.7)	
200–599	319 (65.5)	268 (66.5)	51 (60.7)	
600≤	67 (13.8)	64 (15.9)	3 (3.6)	
Do not know <i>n</i> = 28				
Subjective financial comfort				0.000*
Very worried about the lack of leeway	52 (10.3)	18 (4.3)	34 (39.1)	
Not sufficient leeway and somewhat worried	157 (31.1)	119 (28.5)	38 (43.7)	
No leeway but not worried	251 (49.7)	238 (56.9)	13 (14.9)	
There is leeway	45 (8.9)	43 (10.3)	2 (2.3)	
Unsure <i>n</i> = 9				

Values are *n* (%) for categorical variables

Differences between categorical items were assessed using chi-square tests

* Significantly different between food secure and insecure (**p* < 0.05)

There were no differences in the distribution of age, gender, or number of family members.

The percentage of the food insecurity group was higher than that of the food security group among non-Japanese nationals, families with children, and single-person or four or more-person households.

Households with incomes of less than 2 million yen had a larger proportion of the food insecurity group than the

food security group, while households with incomes of more than 6 million yen had a lower proportion of the food insecurity group.

Similarly, in the distribution of subjective financial comfort, the proportion of the food insecurity group was higher than that of the food security group in households with worry and no security. The proportion of the food insecurity group was lower in households with no security but no worry and in households with security.

Association between food intake status, eating behavior, and food insecurity

Table 2 presents the relationship between dietary intake status and food insecurity. There was a negative association between household dietary diversity scores and being food insecure (OR [95%CI]:0.41 [0.23–0.75] $p = 0.000$). Moreover, this association was identified in the model adjusted for attributes and subjective financial comfort (0.49 [0.24–0.98] $p = 0.001$).

Similarly, there was a negative association between including fruits and vegetables in the diet, eating a nutritionally balanced diet, and eating a satisfactory amount of food and food insecurity. There was a positive association between the belief in the need to improve one's diet and food insecurity.

In the relationship between eating behavior and food insecurity, there was a positive association among the frequency of using instant foods, frozen foods, and other convenient foods, a positive association between missing breakfast for a family member and being food insecure, and a negative association between referring to information on food packages and being food insecure. Nevertheless, this association was not observed in subjective financial comfort adjustment model.

There was a negative association between eating breakfast together every day, eating dinner together every day, and food insecurity.

Association among subjective sense of health, subjective sense of well-being, and food insecurity

The relationship among subjective health, subjective well-being, and food insecurity is depicted in **Table 3**. The relationship between subjective health and food insecurity was negative (0.27 [0.11–0.65] $p = 0.004$) for those aged under 65 years, while the risk rate was 0.051 for those aged over 65 years in a model adjusted for subjective financial comfort, slightly exceeding the criterion for significance. Similarly, there was a negative association (0.29 [0.13–0.62] $p = 0.001$) between a subjective sense of health and food insecurity for women. No association was found for men in the model adjusted for subjective financial comfort.

There was no association between subjective well-being and food insecurity in the model adjusted for subjective financial comfort for those aged under 65 years. However, a negative association (0.35 [0.15–0.78] $p = 0.011$) was found for those 65 years of age and older. Similarly, a negative association (0.36 [0.17–0.78] $p = 0.010$) was found for women. No association was found for men in the model adjusted for subjective financial comfort.

Discussion

This study, the first report on food insecurity in Japan, clarified some of the actual conditions of food insecurity in a large-scale apartment complex. Moreover, it confirmed the relationship between food insecurity and residents' subjective sense of health and subjective sense of well-being. The findings are described below.

First, we described the characteristics of food insecurity in the housing complex. In this study, 17.5% of the households in the housing complex were found to be food insecure. Since the proportion of food insecurity among the total population in Japan is not yet known, we will instead estimate the household food insecurity rate in 2020 in South Korea²²⁾, which is also located in Asia and has a relative poverty rate of around 15%, which is similar to Japan. Compared to the rate of 4.3%, the findings of this study were found to be at a fairly high level. The housing complex has a population of 8.9% under the age of 14 and 35.8% over the age of 65, making it an area with a declining birthrate and an aging population compared to the average for Japan as a whole (11.5% under the age of 14 and 29.1% over the age

Table 2. Association among food intake status, eating behavior, and food insecurity

	Food secure		Food insecure		p value
	OR	95%CI	OR	95%CI	
Dietary intake (status)					
Household dietary diversity score					
n = 464 (good group %)		36.2%		18.3%	
Model 1	1.00	[Reference]	0.41	[0.23–0.75]	0.004
Model 2	1.00	[Reference]	0.49	[0.24–0.98]	0.044
Vegetables and fruits are included					
n = 503 (good group %)		61.8%		25.8%	
Model 1	1.00	[Reference]	0.21	[0.12–0.35]	0.000
Model 2	1.00	[Reference]	0.33	[0.18–0.59]	0.000
Nutritionally balanced meals are available					
n = 501 (good group %)		47.6%		14.6%	
Model 1	1.00	[Reference]	0.18	[0.09–0.33]	0.000
Model 2	1.00	[Reference]	0.30	[0.15–0.59]	0.001
I can eat a satisfying amount of food					
n = 503 (good group %)		83.5%		34.8%	
Model 1	1.00	[Reference]	0.11	[0.06–0.18]	0.000
Model 2	1.00	[Reference]	0.14	[0.08–0.26]	0.000
Improvement of dietary habits is necessary					
n = 495 (necessary group %)		38.4%		72.7%	
Model 1	1.00	[Reference]	4.30	[2.56–7.22]	0.000
Model 2	1.00	[Reference]	3.07	[1.70–5.56]	0.000
Eating habits/behavior					
Use convenience foods					
n = 502 (User group %)		32.9%		48.3%	
Model 1	1.00	[Reference]	2.04	[1.27–3.26]	0.003
Model 2	1.00	[Reference]	1.71	[0.99–2.93]	0.054
Refer to food information					
n = 501 (reference group %)		61.1%		46.1%	
Model 1	1.00	[Reference]	0.54	[0.34–0.86]	0.010
Model 2	1.00	[Reference]	0.74	[0.43–1.28]	0.285
Frequency of eating breakfast together					
n = 468 (reference group %)		39.1%		19.0%	
Model 1	1.00	[Reference]	0.35	[0.19–0.64]	0.001
Model 2	1.00	[Reference]	0.42	[0.21–0.83]	0.013
Frequency of eating dinner together					
n = 468 (frequently eating meals together group %)		46.3%		24.1%	
Model 1	1.00	[Reference]	0.35	[0.20–0.61]	0.000
Model 2	1.00	[Reference]	0.34	[0.18–0.64]	0.001
A family member misses breakfast					
n = 412 (undernourished group %)		26.2%		43.8%	
Model 1	1.00	[Reference]	2.23	[1.35–3.69]	0.002
Model 2	1.00	[Reference]	1.84	[0.98–3.45]	0.059

OR; odds ratio, CI; confidence interval

Model 1; unadjusted

Model 2; adjusted for age, gender, nationality, residence years, household size, household with children, subjective financial comfort

Table 3. Association among subjective sense of health, subjective sense of well-being, and food insecurity

	Food secure		Food insecure		<i>p</i> value
	OR	95%CI	OR	95%CI	
Subjective sense of health (high group %)					
Age <65		63.2%		40.9%	
Model 1	1.00	[Reference]	0.33	[0.16–0.68]	0.002
Model 2	1.00	[Reference]	0.19	[0.08–0.44]	0.000
Model 3	1.00	[Reference]	0.27	[0.11–0.65]	0.004
Age ≥65		60.8%		28.3%	
Model 1	1.00	[Reference]	0.25	[0.13–0.50]	0.000
Model 2	1.00	[Reference]	0.24	[0.12–0.50]	0.000
Model 3	1.00	[Reference]	0.45	[0.20–1.00]	0.051
Male		64.1%		41.9%	
Model 1	1.00	[Reference]	0.40	[0.18–0.88]	0.023
Model 2	1.00	[Reference]	0.33	[0.13–0.79]	0.013
Model 3	1.00	[Reference]	0.50	[0.19–1.31]	0.159
Female		60.7%		30.5%	
Model 1	1.00	[Reference]	0.24	[0.12–0.44]	0.000
Model 2	1.00	[Reference]	0.17	[0.08–0.34]	0.000
Model 3	1.00	[Reference]	0.29	[0.13–0.62]	0.001
Subjective sense of well-being (high group %)					
Age <65		62.2%		50.0%	
Model 1	1.00	[Reference]	0.52	[0.26–1.03]	0.061
Model 2	1.00	[Reference]	0.26	[0.11–0.59]	0.001
Model 3	1.00	[Reference]	0.50	[0.20–1.25]	0.139
Age ≥65		69.9%		28.9%	
Model 1	1.00	[Reference]	0.17	[0.09–0.35]	0.000
Model 2	1.00	[Reference]	0.18	[0.09–0.36]	0.000
Model 3	1.00	[Reference]	0.35	[0.15–0.78]	0.011
Male		64.1%		45.2%	
Model 1	1.00	[Reference]	0.45	[0.20–1.00]	0.049
Model 2	1.00	[Reference]	0.28	[0.11–0.71]	0.007
Model 3	1.00	[Reference]	0.51	[0.18–1.40]	0.190
Female		67.9%		36.2%	
Model 1	1.00	[Reference]	0.23	[0.12–0.42]	0.000
Model 2	1.00	[Reference]	0.17	[0.09–0.34]	0.000
Model 3	1.00	[Reference]	0.36	[0.17–0.78]	0.010

OR; odds ratio CI; confidence interval

model 1; unadjusted

model 2; adjusted for age, gender, nationality, residence years, household size, household with children

model 3; adjusted for age, gender, nationality, residence years, household size, household with children, subjective financial comfort

of 65). It is also an area where single-person households and immigrants are moving into the area in search of inexpensive housing. Due to regional characteristics where there are many residents with low incomes who are considered socially vulnerable, it is assumed that the problem of food insecurity is becoming more serious in such housing complexes in Japan.

Although previous studies have stated that attributes such as age and gender are related to the risk factors of food insecurity²³⁾, no relationship with these attributes was confirmed in the housing complex in question. Looking at the relative poverty rate in Japan by household type, the poverty rate (53.4%) is particularly high among households comprising a single parent and children²⁴⁾. As the percentage of food insecurity was high among households with young tenants and those with children in the housing complex, a detailed study focusing on single-parent households in this category is desirable. Additionally, the rate of food insecurity is high among immigrants, especially in Asia-Pacific countries, and is associated with a decline in mental well-being²⁵⁾. In this study, similarly, a high rate of food insecurity was observed among foreign residents.

Subsequently, we discuss the relationship between food insecurity and dietary intake. Food insecure households are less likely to have a diverse diet and less likely to eat a satisfactory amount of food. Further, 70% of food insecurity respondents felt the need to improve their dietary habits. This result supports the findings of many previous studies, that is, the food insecurity has negative effects on the quality of adults' diet, especially on the intake of nutritious vegetables, fruits and dairy products which promote human health²⁶⁾.

Moreover, the lower the household income, the higher the rate of food insecurity. These results provide evidence that the Japanese version of the HFSSM can evaluate the same concepts as the original instrument.

Furthermore, we discuss the relationship between food security and eating behavior. Food insecurity households were less likely to eat breakfast and dinner together with their family members than were households without food insecurity. As eating alone more frequently may cause depression and affect quality of life²⁷⁾, solitary eating in food insecurity households is a eating behavior issue that should be improved. According to previous studies, food insecurity in households is a predictor of such eating behaviors as the use of convenience foods such as frozen foods²⁸⁾, the use of food information⁴⁾, and the absence of breakfast among family members²⁹⁾. Nonetheless, in this study, these eating behaviors were found to be more strongly related to the level of subjective financial comfort than to food insecurity.

Finally, we discuss the relationship between food insecurity and subjective health and subjective well-being. Food insecurity is known to be negatively related to subjective health and subjective happiness in previous studies^{30,31)}. Conversely, food insecurity was not an independent factor of subjective health and subjective well-being among the residents of the complex, especially among men, when adjusted for subjective financial comfort. In this regard, it has been reported that women's subjective health and subjective sense of well-being declined more than men's^{32–34)}, suggesting that men are generally more tolerant of food insecurity than women. However, as domestic data on food insecurity are not available and comparisons cannot be made, it cannot be determined whether this is a characteristic of residents of large apartment complexes. Additionally, food insecurity was a dependent factor of subjective well-being among the residents of the housing complex, even among those aged under 65 years, when adjusted for subjective financial comfort. Although previous findings have not provided a consistent view of the relationship between food insecurity and subjective well-being according to age, a public opinion poll³⁵⁾ conducted by the Cabinet Office in Japan showed gender and age differences in the sense of fulfillment in daily life. A higher percentage of women and elderly cited the time when they were resting and relaxing, while a higher percentage of men and the younger generation cited the time when they were absorbed in their hobbies and sports. Satisfaction with leisure and leisure-time activities was higher among men and the younger generation. Therefore, we speculate that hobbies and leisure activities play a significant role in the subjective well-being of men and the younger generation and that the influence of food insecurity is relatively small.

These findings suggest that support for food insecurity may increase the subjective sense of health, especially among women, and the subjective sense of well-being among women and the elderly in this housing complex. This is

an important perspective for revitalization strategies for large apartment complexes concerned about declining vitality. According to the latest OECD comparison of poverty rates, Japan's poverty rate in 2018 was 15.7%, the 8th highest among member countries and the highest among developed countries³⁶⁾. Recently, in the U.S. and Canada, food assistance as a social security measure and community organization activities have been enhanced for food-insecure households^{37,38)}. By adopting the concept of assessing household poverty from the perspective of diet and developing a food support system, it will be possible to provide adequate nutritional support to malnourished citizens. This study provides evidence for the feasibility of using the concept of household food security in Japan and other East Asian countries.

Study strengths and limitations

This is the first study in Japan to assess residents' food poverty using the concept of household food security, providing valuable data for future social security policies in large housing complexes. However, this study has several limitations. First, the survey response rate was 8.8%. Since this low rate may cause characteristic bias between respondents and non-respondents, the results include sampling bias possibly. In addition, the results are not generalizable to other housing complexes in regional cities in Japan. Further, the results are limited to the relationship between food insecurity and household dietary habits, as the dietary intake and eating behaviors discussed are only a part of the total.

Moreover, as the nature of this study is exploratory rather than hypothesis testing, we could not elucidate the mechanism of the findings. Further comparative verification is necessary to build on the findings from other housing complexes and other regions in Japan.

Conclusions

We confirmed household food insecurity in a large-scale apartment complex in Japan and identified that households with food insecurity have less food diversity, less nutritionally balanced diets, less satisfactory food intake. The results also showed that the frequency of family meals might be low. Furthermore, food insecure residents tended to have lower subjective well-being and subjective sense of health than those who are food secure.

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Author Contributions

Wakimoto K. and Fujita Y. pioneered the study and developed the statistical analysis plan. Wakimoto K. and Hisanari M. analyzed the data. Wakimoto K. prepared the first draft of the manuscript; Hisanari M., Fujita Y., Ohtsubo A., Fujii T., Kato J., Ogasawara H., Kudo D., Fukui M. contributed to the writing of the manuscript. All authors reviewed the final version of the manuscript and came to an agreement.

Conflict of Interest

The authors declared no potential conflicts of interest concerning the research, authorship, and/or publication of this article.

References

1. Sakamoto J. Analysis of the relationship between population decline/aging population in the future and spatial indicators (Japanese). *J Jpn Assoc Incl Soc* 24; 85–96: 2023.
2. Regional Revitalization Promotion Secretariat, Cabinet Office. Revitalization of residential complexes. <https://www.chisou.go.jp/tiiki/tiikisaisei/danchisaisei.html>. (accessed on 2nd February, 2024)
3. Kawamura T. Perception of community among people receiving welfare services and living in large public housing areas (Japanese). *J Poverty* 16; 90–99: 2016.
4. Tanaka M, Miyake J. A study on concentration of the aged and low-income group into public housing. *J City Plan Inst Jpn* 21; 367–372: 1986.
5. Inaba Y, Ishii Y, Igarashi A, et al. A study on the residence of foreigners in rental housing of urban renaissance agency and public housing. *J Archit Plann, AIJ* 75; 2397–2406: 2010.
6. Mikami Y, Motokawa K, Shirobe M, et al. Relationship between eating alone and poor appetite using the simplified nutritional appetite questionnaire. *Nutrients* 14; 337: 2022.
7. National Research Council. Food insecurity and hunger in the United States: an assessment of the measure. Washington, DC, The National Academies Press, 2006.
8. U.S. Department of Agriculture ERS. Definitions of food security. <https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-u-s/definitions-of-food-security/>. (accessed on 2nd February, 2024)
9. U.S. Department of Agriculture ERS. Survey tools. <https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-u-s/survey-tools/>. (accessed on 2nd February, 2024)
10. Leung C W, Epel E S, Ritchie L D, et al. Food insecurity is inversely associated with diet quality of lower-income adults. *J Acad Nutr Diet* 114; 1943–1953: 2014.
11. Shinwell J, Bateson M, Nettle D, et al. Food insecurity and patterns of dietary intake in a sample of UK adults. *Br J Nutr* 28; 770–777: 2022.
12. Men F, Elgar F J, Tarasuk V. Food insecurity is associated with mental health problems among Canadian youth. *J Epidemiol Community Health* 75; 741–748: 2021.
13. Zhang J, Wang Y, Yen ST. Does supplemental nutrition assistance program reduce food insecurity among households with children? Evidence from the current population survey. *Int J Environ Res Public Health* 18; 3178: 2021.
14. Hudak KM, Racine EF, Shulkind L. An increase in SNAP benefits did not impact food security or diet quality in youth. *J Acad Nutr Diet* 121; 507–519: 2021e12.
15. Chiu WY, Yuan TL, Yi CC, et al. Perceived food insecurity, dietary quality, and unfavorable food intake among children and adolescents from economically disadvantaged households. *Nutrients* 13; 3411: 2021.
16. Yang Q, Yuan T, Yang L, et al. Household food insecurity, dietary diversity, stunting, and anaemia among left-behind children in poor rural areas of China. *Int J Environ Res Public Health* 16; 4778: 2019.
17. U.S. Department of Agriculture. U.S. Household Food Security Survey Module: Six-Item Short Form. <https://www.ers.usda.gov/media/8282/short2012.pdf>. (accessed on 2nd February, 2024)
18. Guide to measuring household food security. Office of Analysis, Nutrition, and Evaluation Food and Nutrition Service, USDA. <https://nhis.ipums.org/nhis/resources/FSGuide.pdf>. (accessed on 2nd February, 2024)
19. Food and nutrition technical assistance. Household Dietary Diversity Score (HDDS) for Measurement of Household Food Access. https://www.fantaproject.org/sites/default/files/resources/HDDS_v2_Sep06_0.pdf. (accessed on 2nd February, 2024)
20. Household Dietary Diversity Score (HDDS) for Measurement of Household Food Access: Indicator Guide. <https://www.fantaproject.org/monitoring-and-evaluation/household-dietary-diversity-score>. (accessed on 2nd February, 2024)
21. The Fourth Basic Plan for the Promotion of Shokuiku. Ministry of Agriculture, Forestry and Fisheries. <https://www.maff.go.jp/j/syokuiku/attach/pdf/kannrenhou-24.pdf> (Japanese). (accessed on 2nd February, 2024)
22. Choi J-H. Food insecurity is associated with dietary consumption during the COVID-19 pandemic: data from the Korea National Health and Nutrition Examination Survey 2019–2020. *Nutrients* 15; 772: 2023.
23. Gundersen C, Ziliak JP. Food insecurity research in the United States: where we have been and where we need to go. *Appl Econ Perspect Policy* 40; 119–135: 2018.
24. Statistics Bureau, Ministry of Internal Affairs and Communications. National Household Structure Survey 2019 (Japanese). <https://www.stat.go.jp/data/zenkokukakei/2019/pdf/gaiyou0831.pdf>. (accessed on 2nd February, 2024)
25. Dou N, Murray-Kolb L, Mitchell D, et al. Food insecurity and mental well-being in immigrants: a global analysis. *Am J Prev Med* 63; 301–311: 2022.
26. Hanson KL, Connor LM. Food insecurity and dietary quality in US adults and children: a systematic review. *Am J Clin Nutr*

- 100; 684–692: 2014.
27. Kwon Y, Hong KH, Park Y-K, et al. How does the frequency of eating-alone among older people in Korea affect their health and dietary behavior? *Nutrients* 26; 15; 2085: 2023.
28. Butcher LM, O'Sullivan TA, Ryan MM, et al. To dine in or not to dine in: a comparison of food selection and preparation behaviours in those with and without food security. *Health Promot J Austr* 32; 267–282: 2021.
29. Lee YS, Kim TH. Household food insecurity and breakfast skipping: their association with depressive symptoms. *Psychiatry Res* 271; 83–88: 2019.
30. Pak TY, Kim GS. Food stamps, food insecurity, and health outcomes among elderly Americans. *Prev Med* 130; 105871: 2020.
31. Frongillo EA, Nguyen HT, Smith MD, et al. Food insecurity is associated with subjective well-being among individuals from 138 countries in the 2014 Gallup World Poll. *J Nutr* 147; 680–687: 2017.
32. Hanmer J, DeWalt DA, Berkowitz SA. Association between food insecurity and health-related quality of life: a nationally representative survey. *J Gen Intern Med* 36; 1638–1647: 2021.
33. Debreczeni FA, Bailey PE. A systematic review and meta-analysis of subjective age and the association with cognition, subjective well-being, and depression. *J Gerontol-B Psychol Sci Soc Sci* 76; 471–482: 2021.
34. Pirrie M, Harrison L, Angeles R, et al. Poverty and food insecurity of older adults living in social housing in Ontario: a cross-sectional study. *BMC Public Health* 20; 1320: 2020.
35. Public opinion survey on national life. Cabinet Office. <https://survey.gov-online.go.jp/r04/r04-life/2.html#midashi10>. (accessed on 2nd February, 2024)
36. Poverty rate (indicator). OECD (2023). <https://data.oecd.org/inequality/poverty-rate.htm>. (accessed on 2nd February, 2024)
37. Supplemental Nutrition Assistance Program (SNAP). U.S. Department of Agriculture. <https://www.nutrition.gov/topics/food-security-and-access/food-assistance-programs/supplemental-nutrition-assistance-program>. (accessed on 2nd February, 2024)
38. Food connections. Toronto Food Policy Council. https://torontourbangrowers.org/img/upload/food_connections_report.pdf. (accessed on 26th September, 2023)