Original

Associations of appetite with anthropometric measurements, mental health, dietary and nutritional status: a cross-sectional study in elderly Japanese people attending a day-care facility

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ABSTRACT Our study investigated the prevalence of poor appetite (PA) and its associations with anthropometric measurements, mental health, dietary and nutritional status in the elderly. We analyzed 71 participants (26 men, 45 women) at a day-care facility in City N and surveyed their basic characteristics (age, sex, support/care level, and living status), anthropometric measurements (including height, weight, calf circumference), mental health status (Geriatric Depression Scale-15 [GDS-15], Philadelphia Geriatric Center Morale Scale [PGC-MS]), appetite (Japanese version of the Council on Nutrition Appetite Questionnaire), and nutritional status (Mini Nutritional Assessment, food frequency questionnaire). The participants were divided into a PA group and a good appetite (GA) group. Between-group differences were examined using the Mann-Whitney U test or chi-square test. Binary logistic regression analysis was conducted assigning 0 to PA and 1 to GA as dependent variables and using the relevant factors as independent variables. The prevalence of PA was 38% overall. Significant between-group differences were noted for living status, calf circumference, GDS-15 score, and PGC-MS. Intakes of energy, protein, other nutrients and various food groups in the PA group were significantly lower than those in the GA group. The proportion of individuals with insufficient/inadequate intake of energy was greater in the PA group than in the GA group. Regression analysis demonstrated significant relationships of appetite with living status (odds ratio 3.838, 95% confidence interval 1.136–12.969) and protein consumption/standard body weight (9.449, 1.285–69.487). Assessment of appetite in elderly persons needing nursing support/care seems important for the prevention of undernutrition or malnutrition.
Keywords: appetite, assessment, elderly, nutrient consumption, undernutrition

INTRODUCTION

Undernutrition or malnutrition constitutes a major health problem in the elderly, causing sarcopenia and frailty, increasing the need for nursing support/care, and acting as a trigger for higher morbidity and mortality (1-3). Screening with the Mini Nutritional Assessment (MNA®) tool found that approximately 50% of community-dwelling elderly persons attending day-care facilities or receiving home care were at risk of malnutrition and 10%–20% were malnourished (4-6); these figures were 40%–60% and 15%–30%, respectively, for elderly persons residing in nursing homes (7-9). Thus, the risk of malnutrition can be as high as 50% in elderly persons, whether they live in the community or in nursing homes.

Poor appetite (PA) appears to precede weight loss and undernutrition by causing lowered and/or imbalanced intake of energy and nutrients. Appetite is affected by various factors in the elderly, including age-related frailty and chronic diseases, socioeconomic factors including financial difficulty, residential and living status, and psychological stress (10,11). To the best of our knowledge, there have been few surveys of the associations of appetite with these factors, dietary and nutritional status in elderly persons attending day-care facilities in Japan. In this study, we investigated the prevalence of PA and associations of appetite with anthropometric measurements,

mental health, dietary and nutritional status in an elderly Japanese population for early intervention to prevent undernutrition or malnutrition.

MATERIALS AND METHODS

Study population. Eighty-three elderly individuals attending a day-care facility in City N, Aichi Prefecture, Japan, were initially eligible for an interview-based survey conducted between February and March 2015. After excluding 12 individuals due to incomplete information, data from the remaining 71 participants (26 men, 45 women) were available for analysis. The study protocol was approved by the Ethics Committee of Nagoya University of Arts and Sciences (approval number 94), and all participants provided written informed consent.

Basic characteristics. We obtained information on age, sex, care needs level (Support level 1 or 2, Care level 1–4) as defined by the Long-term Care Insurance System (12), number of medicines (categorized as 0 for fewer than 4 prescribed agents, and 1 for 4 or more agents), and living status (living alone or with others).

Anthropometric measurements. Height was measured using a digital height measurement device (YG-200DN; Yagami KK, Osaka, Japan). Body weight and body composition were determined using a portable device (In Body 430; Takumi KK, Tokyo, Japan). BMI was calculated as weight (kg)/height (m)2. Grip strength was measured twice in the left hand and right hand each using a digital grip dynamometer (T.K.K. 5401; Takei Instrument Industry KK, Niigata, Japan), and the average values were recorded. Arm and calf circumferences were measured, and the average values were calculated for both sides.

Mental health. Depression was assessed using the Geriatric Depression Scale (GDS-15) (13,14). A negative answer was scored as 1 and a positive answer as 0, with a maximum total score of 15. A total score of 0–4 indicates no depression, a total score of 5–10 a tendency for depression, and a total score of ≥11 depression. In this study, participants with a GDS-15 score of <5 were considered to be non-depressed, while those with a score of ≥5 to be depressed.

The Philadelphia Geriatric Center Morale Scale (PGC-MS) was used to measure subjective psychosocial well-being (15). An affirmative answer was scored as 1 and a negative answer as 0, with a maximum total score of 17. According to the instrument guidelines, scores of 13–17 were considered high, scores of 10–12 within the mid-range, and scores <9 at the low end of the scale.

Appetite. Appetite was assessed using the Japanese version of the Council on Nutrition Appetite Questionnaire (CNAQ-J) (16). The original version was developed by Wilson et al. (17). This questionnaire comprises 8 items with a maximum of 5 points each, for a total of 40 points. Individuals with a score of 8–16 may be at risk of anorexia and need nutritional counseling, those with a score of 17–28 may need frequent re-evaluation, and a score ≤28 may predict at risk of 5% weight loss within 6 months. In our study, individuals with a CNAQ-J score of ≤28 were allocated to a PA group and those with a score of ≥29 to a good appetite (GA) group.

Dietary and nutritional status. Dietary and nutritional status was evaluated using the MNA® (18), which consists of 6 screening items (maximum 14 points) including changes in food intake and body weight, and 12 assessment items (maximum 16 points) such as living environment and prescribed medication status. Scores were summed (maximum 30 points), and nutritional status was defined as malnutrition <17 points, at risk of malnutrition 17–23.5 points, or normal nutrition ≥24 points.

Participants were also assessed using a food frequency questionnaire with confirmed validity and reproducibility (version 3.5, based on the Standard Tables of Food Composition in Japan) (19), which asks about the frequency of intake of 29 food items with 10 cooking methods. Intakes were estimated for energy, 4 macronutrients (protein, lipids, carbohydrates, and dietary fibers), 8 minerals and vitamins (calcium, iron, zinc, vitamins A, B1, B2, C, and D) and were calculated for 13 food groups (cereals, potatoes, legumes, green and yellow vegetables, other vegetables, seaweeds, fish and shellfish, meat, eggs, milk and dairy products, fruits, confectionery, oils and fats).

Intakes of energy and protein per standard body weight (kg) (22.0 [BMI] × height [m]2) were also calculated in addition to crude values and per body weight values (kg). BMI <21.5 was considered to reflect insufficient consumption of energy according to the 2020 Dietary Reference Intakes for Japanese (20).

Statistical analysis. Median differences in participant's characteristics, anthropometric measurements, mental health, and nutritional status were compared between the PA and GA groups using the Mann-Whitney U test, a 2×2 table examined by the chi-square test or Fisher's direct method, or a 2×3 table examined by the chi-square test. Spearman's rank correlation coefficients were calculated between CNAQ-J and relevant parameters. Using the forced entry method, binary logistic regression analysis was performed assigning 0 to PA and 1 to GA as the dependent variables, with relevant factors as independent variables adjusted for age and sex. In view of the rather small sample size, the independent variables were narrowed down considering the correlation coefficients and collinearity of the variables in the categories of mental health and nutrient intake. All statistical analyses were conducted using SPSS version 22.0 (IBM Corp., Armonk, NY). A two-sided p-value of <0.05 was considered statistically significant.

RESULTS

Basic characteristics. The 71 participants (26 men [36.6%], 45 women [63.4%]) had a median age of 82 years (interquartile range [IQR] 76, 87) (Table 1). The prevalence of PA was 38.0% (n=27) and that of GA 62.0% (n=44). The CNAQ-J scores were 29 (IQR 27, 32) for all participants, 27 (IQR 20, 28) for the PA group, and 31 (IQR 30, 33) for the GA group.

Overall, 30 participants (42.3%) required Support level 1 or 2, 32 (45.1%) Care level 1 or 2, and 9 (12.7%) Care level 3 or 4. There was no significant difference in age, sex, Support/Care level, or number of prescribed agents between the PA and GA groups. The prevalence of living alone was significantly greater in the PA group than in the GA group (51.9% vs 27.3%, p=0.045).

Height could not be measured in 3 participants and body weight could not be measured in 10 because of difficulty in standing erect, having a rounded spine, or declining to participate in the examination. Therefore, the analyses of nutrient intake per standard body weight were based on data for 68 participants, while those involving body weight, BMI, and skeletal muscle mass were based on data for 61 participants. BMI was lower in the PA group than in the GA group (21.0 [IQR 19.5, 23.6] vs 22.8 [IQR 20.1, 25.7]); however, the difference was not statistically significant. Calf circumference was significantly smaller in the PA group (31.0 cm [IQR 29.0, 33.0] vs 33.0 cm (IQR 30.3, 35.0]; p=0.033). There was no significant between-group difference in skeletal muscle mass, arm circumference, or grip strength.

Mental health. The GDS-15 score was significantly higher in the PA group than in the GA group (5 [IQR 3, 8] vs 3 [IQR 1, 6]; p=0.005). The proportion of depression was greater in the PA group (55.6% vs 31.8%), but the difference was not statistically significant (p=0.081). The PGC-MS score was significantly lower in the PA group (10 [IQR 7, 12] vs 12 [IQR 9, 13]; p=0.040).

Table 1. Characteristics of the elderly participants, and comparison of anthropometric measurements and mental health by appetite status

	All participants		Poor appetite group		Good appetite group		*p*-value [b]
	n	Median [IQR [a]] or (%)	n	Median [IQR] or (%)	n	Median [IQR] or (%)	
CNAQ-J score [c]	71	29 [27, 32]	27	27 [20, 28]	44	31 [30, 33]	<0.001
Age (years)	71	82 [76, 87]	27	81 [74, 87]	44	82 [77, 80]	0.614
Sex (men/women)	26/45	(36.6)	10/17	(37.0)	16/28	(36.4)	0.999
LTCI care needs level [d]							
Support level 1 or 2	30	(42.3)	18	(40.7)	19	(43.2)	
Care level 1 or 2	32	(45.1)	14	(51.8)	18	(40.9)	0.927
Care level 3 or 4	9	(12.7)	2	(7.4)	7	(15.9)	
At least 4 prescribed medicines	45	(63.4)	18	(66.7)	27	(61.4)	0.801
Living alone	26	(36.6)	14	(51.9)	12	(27.3)	0.045
Anthropometric measurements							
Height (cm)	68	148.7 [142.9, 154.7]	27	149.3 [141.5, 156.2]	41	147.8 [143.0, 154.4]	0.764
Body weight (kg)	61	49.9 [42.9, 56.7]	24	46.9 [41.1, 55.5]	37	52.6 [43.5, 57.7]	0.238
BMI (kg/m^2)	61	22.1 [19.8, 25.3]	24	21.0 [19.5, 23.6]	37	22.8 [20.1, 25.7]	0.112
Skeletal muscle mass (kg)	61	17.4 [15.2, 20.8]	24	16.7 [15.4, 19.5]	37	17.6 [15.0, 21.0]	0.585
Arm circumference (cm)	71	26.0 [23.0, 28.0]	27	26.0 [22.0, 28.0]	44	27.0 [24.0, 28.0]	0.225
Calf circumference (cm)	71	32.0 [30.0, 34.0]	27	31.0 [29.0, 33.0]	44	33.0 [30.3, 35.0]	0.033
Grip strength (kg)	71	17.0 [12.9, 21.3]	27	16.6 [12.9, 19.2]	44	17.9 [12.9, 22.0]	0.485
Mental health							
GDS-15 score [e]	71	4 [2, 6]	27	5 [3, 8]	44	3 [1, 6]	0.005
Depression (GDS-15 score ≥ 5)	29/71	(40.8)	15/27	(55.6)	14/44	(31.8)	0.081
PGC Morale Scale score [f]	71	11 [8, 13]	27	10 [7, 12]	44	12 [9, 13]	0.040

[a] Interquartile range.

[b] Median values were examined by the Mann-Whitney *U* test, and proportions by the chi-square test or Fisher's direct test.

[c] Council on Nutrition Appetite Questionnaire for Japanese.

[d] Long-Term Care Insurance System.

[e] Geriatric Depression Scale-15.

[f] Philadelphia Geriatric Center Morale Scale.

Dietary and nutritional status. The MNA® score was 24 (IQR 22, 26) and the proportion with malnutrition or at risk of malnutrition was 49.2% overall with no significant difference between the GA and PA groups (Table 2).

Overall, dietary intakes were as follows: energy 1,473 kcal (IQR 1,228, 1,703), protein 52.8 g (IQR 43.5, 65.5), lipids 42.5 g (IQR 33.0, 55.2), carbohydrates 212.6 g (IQR 180.1, 236.1), and zinc, a crucial mineral for taste that influences appetite, 6.6 mg (IQR 5.4, 7.6). Intakes of nutrients (energy, protein, lipids, carbohydrates, dietary fibers, iron, zinc, vitamins B_1, B_2, C, and D) were significantly lower in the PA group than in the GA group ($p<0.05$).

Table 2. Comparison of nutritional status, and intakes of nutrients and food groups according to appetite status

	All participants		Poor appetite group		Good appetite group		*p*-value [b]
	n	Median [IQR [a]] or (%)	n	Median [IQR] or (%)	n	Median [IQR] or (%)	
Nutritional status							
MNA® score [c]	61	24 [22, 26]	24	24 [20, 26]	37	25 [22, 26]	0.103
Malnutrition or at risk of malnutrition (MNA® score ≤23.5)	30	(49.2)	13/24	(54.2)	17/37	(45.9)	0.605
Consumption of energy and nutrients							
Energy (kcal)	71	1,473 [1,228 1,703]	27	1,330 [1,107, 1,578]	44	1,605 [1,334, 1,745]	0.006
Energy (kcal)/body weight (kg)	61	30 [25, 35]	24	29 [23, 35]	37	31 [26, 36]	0.281
Energy (kcal)/standard body weight (kg) [d]	68	30 [25, 35]	27	27 [21, 35]	41	33 [28, 36]	0.008
Insufficient energy intake (BMI<21.5)	27/61	(44.3)	15/24	(62.5)	12/37	(32.4)	0.034
Protein (g)	71	52.8 [43.5, 65.5]	27	45.8 [33.6, 56.0]	44	55.8 [49.6, 71.3]	0.003
Protein (g)/body weight (kg)	61	1.08 [0.85, 1.32]	24	0.98 [0.75, 1.23]	37	1.18 [0.92, 1.33]	0.057
Protein (g)/standard body weight (kg)	68	1.03 [0.84, 1.37]	27	0.97 [0.73, 1.20]	41	1.19 [0.99, 1.46]	0.003
Lipids (g)	71	42.5 [33.0, 55.2]	27	38.6 [26.1, 46.4]	44	46.4 [34.7, 60.3]	0.015
Carbohydrates (g)	71	212.6 [180.1, 236.1]	27	198.1 [149.4, 226.2]	44	217.0 [195.0, 245.1]	0.040
Dietary fibers (g)	71	11.6 [8.8, 13.7]	27	9.6 [7.1, 12.2]	44	12.6 [9.4, 14.9]	0.004
Calcium (mg)	71	477 [331, 554]	27	426 [282, 525]	44	488 [412, 597]	0.061
Iron (mg)	71	5.9 [4.5, 7.3]	27	5.6 [3.9, 6.3]	44	6.0 [4.8, 7.9]	0.017
Zinc (mg)	71	6.6 [5.4, 7.6]	27	5.8 [4.1, 6.9]	44	7.0 [5.9, 8.4]	0.002
Vitamin A (μg RAE) [e]	71	493 [330 , 629]	27	438 [322, 523]	44	540 [351, 663]	0.079
Vitamin B_1 (mg)	71	0.73 [0.56, 0.88]	27	0.66 [0.53, 0.78]	44	0.79 [0.58, 1.00]	0.025
Vitamin B_2 (mg)	71	0.84 [0.66, 1.04]	27	0.73 [0.61, 0.89]	44	0.93 [0.71, 1.12]	0.025
Vitamin C (mg)	71	96 [64, 116]	27	71 [44, 99]	44	103 [71, 124]	0.003
Vitamin D (μg)	71	6.4 [3.6, 8.1]	27	4.2 [2.9, 7.0]	44	6.7 [4.7, 8.9]	0.010
Consumption of food groups							
Cereals (g)	71	336 [270, 398]	27	330 [222, 384]	44	345 [314, 405]	0.135
Potatoes (g)	71	21 [7, 43]	27	14 [7, 29]	44	21 [7, 50]	0.144
Green and yellow vegetables (g)	71	75 [50, 111]	27	71 [50, 100]	44	86 [50, 123]	0.149
Other vegetables (g)	71	129 [95, 193]	27	109 [91, 160]	44	167 [104, 210]	0.023
Seaweeds (g)	71	3 [1, 5]	27	2 [1, 4]	44	5 [2, 7]	0.003
Legumes (g)	71	35 [20, 55]	27	20 [10, 40]	44	40 [30, 69]	0.002
Fish and shellfish (g)	71	54 [31, 79]	27	41 [23, 70]	44	68 [45, 91]	0.006
Meat (g)	71	51 [29, 80]	27	49 [20, 63]	44	69 [34, 91]	0.060
Eggs (g)	71	14 [7, 29]	27	14 [7, 25]	44	21 [14, 36]	0.142
Milk and dairy products (g)	71	92 [33, 190]	27	109 [8, 186]	44	87 [50, 195]	0.648
Fruits (g)	71	86 [43, 150]	27	75 [32, 107]	44	150 [64, 150]	0.021
Confectionery (g)	71	27 [10, 52]	27	43 [11, 65]	44	23 [9, 47]	0.213
Fats and oils (g)	71	6 [3, 11]	27	5 [2, 9]	44	8 [4, 13]	0.021

[a] Interquartile range.

[b] Median values were examined using the Mann-Whitney *U* test, and proportions by the chi-square test.

[c] Mini Nutritional Assessment.

[d] Standard body weight: [22 × height(m)^2] kg.

[e] Retinol activity equivalents (μg).

No significant difference was noted in energy consumption per body weight between the two groups; however, energy consumption per standard body weight was significantly lower in the PA group than in the GA

group (27 kcal/kg [IQR 21, 35] vs 33 kcal/kg [IQR 28, 36]; p=0.008). The proportion of individuals with insufficient energy consumption (BMI<21.5kg/m^2) was greater in the PA group (62.5% vs 32.4%; p=0.034).

No significant difference was noted in protein consumption per body weight between the two groups, either; however, the value per standard body weight was significantly lower in the PA group than in the GA group (0.97 g/kg [IQR 0.73, 1.20] vs 1.19 g/kg [IQR 0.99, 1.46]; p=0.003).

In terms of protein sources, intakes of legumes, fish and shellfish were significantly lower in the PA group than in the GA group (legumes: 20 g [IQR 10, 40] vs 40 g [IQR 30, 69]; fish and shellfish: 41 g [IQR 23, 70] vs 68 g [IQR 45, 91]; both p<0.01). Consumption of meat tended to be lower in the PA group (p=0.06). The intakes of other vegetables, seaweeds, fruits, fats and oils were significantly lower in the PA group than in the GA group (p<0.05).

Table 3. Correlations between CNAQ-J[a] score and anthropometric measurements, mental health status and dietary consumption

	n	r [b]	p -value
Age (years)	71	0.033	0.783
BMI	61	0.230	0.074
Calf circumference (cm)	71	0.313	0.008
GDS-15 score [c]	71	-0.313	0.008
PGC-MS [d]	71	0.313	0.008
MNA® score [e]	61	0.231	0.073
Energy (kcal)	71	0.345	0.003
Energy (kcal)/body weight (kg)	61	0.229	0.076
Energy (kcal)/standard body weight (kg) [f]	68	0.375	0.002
Protein (g)	71	0.370	0.001
Protein (g)/body weight (kg)	61	0.299	0.019
Protein (g)/standard body weight (kg)	68	0.405	0.001
Lipids (g)	71	0.288	0.015
Carbohydrates (g)	71	0.276	0.020
Dietary fibers (g)	71	0.329	0.005
Calcium (mg)	71	0.265	0.025
Iron (mg)	71	0.281	0.018
Zinc (mg)	71	0.395	0.001
Vitamin A (μg RAE) [g]	71	0.231	0.052
Vitamin B_1 (mg)	71	0.277	0.019
Vitamin B_2 (mg)	71	0.308	0.009
Vitamin C (mg)	71	0.348	0.003
Vitamin D (μg)	71	0.272	0.022
Cereals (g)	71	0.200	0.094
Potatoes (g)	71	0.144	0.232
Green and yellow vegetables (g)	71	0.167	0.163
Other vegetables (g)	71	0.260	0.029
Seaweeds (g)	71	0.372	0.001
Legumes (g)	71	0.332	0.005
Fish and shellfish (g)	71	0.309	0.009
Meat (g)	71	0.187	0.121
Eggs (g)	71	0.233	0.050
Milk and dairy products (g)	71	0.144	0.231
Fruits (g)	71	0.300	0.011
Confectionery (g)	71	-0.130	0.280
Fats and oils (g)	71	0.270	0.023

[a] Council on Nutrition Appetite Questionnaire for Japanese.

[b] Spearman's rank correlation coefficient.

[c] Geriatric Depression Scale-15.

[d] Philadelphia Geriatric Center Morale Scale.

[e] Mini Nutritional Assessment.

[f] Standard body weight: [22 × height (m)^2] kg.

[g] Retinol activity equivalents (μg).

Correlations between CNAQ-J score and relevant factors. The Spearman's rank correlation coefficient between the CNAQ-J score and calf circumference was statistically significant (r=0.313, p=0.008), as was the PGC-MS score (r=0.313, p=0.008). (Table 3). The GDS-15 score was negatively associated with CNAQ-J score (r=

-0.313, p=0.008). The correlation coefficients between the CNAQ-J score and age, BMI, and MNA® were not statistically significant.

Intakes of energy (r=0.345, p=0.003), protein (r=0.370, p=0.001), dietary fibers (r=0.329, p=0.005), zinc (r=0.395, p=0.001), and other 8 nutrients were significantly associated with CNAQ-J score. Intakes of legumes (r=0.332, p=0.005), fish and shellfish (r=0.309, p=0.009), and other 4 food items were also significantly associated with CNAQ-J score.

Binary logistic regression analysis. The GDS-15 score was negatively associated with the PGC-MS score (r= -0.623), and protein consumption was strongly correlated with intakes of energy (r=0.907) and zinc (r=0.962). Calf circumference, living status, GDS-15 score (as a mental health status marker), and protein consumption (as a marker of energy and nutrient intake) were used as independent variables. Analyses were performed using two models (model 1, crude protein consumption; model 2, protein consumption per standard body weight). Factors associated with appetite were living status (odds ratio [OR] 4.237, 95% confidence interval [CI] 1.246–14.408) and crude protein consumption (OR 1.050, 95% CI 1.007–1.095) according to model 1, while living status (OR 3.838, 95% CI 1.136–12.969) and protein consumption per standard body weight (OR 9.449, 95% CI 1.285–69.487) according to model 2 (Table 4).

Table 4. Final results of binary logistic regression analysis according to the forced entry method

	Model 1[a]				Model 2[b]			
	OR[c]	95% CI[d]		*p* -value	OR	95% CI		*p* -value
Calf circumference (cm)	1.116	0.911	1.367	0.291	1.095	0.893	1.344	0.381
Living status[e]	4.237	1.246	14.408	0.021	3.838	1.136	12.969	0.030
GDS-15 (score)[f]	0.850	0.710	1.017	0.076	0.853	0.711	1.024	0.089
Crude protein consumption (g)	1.050	1.007	1.095	0.023	–	–	–	–
Protein consumption (g)/standard body weight (kg)[g]	–	–	–	–	9.449	1.285	69.487	0.027

[a] Model 1: calf circumference, living status, GDS-15, and crude protein consumption.

[b] Model 2: calf circumference, living status, GDS-15, and protein consumption/standard body weight.

[c] Odds ratio: adjusted for sex and age.

[d] 95% confidence interval.

[e] 0, living alone; 1, living with other(s).

[f] Geriatric Depression Scale-15.

[g] Standard body weight: [22 × height $(m)^2$] kg.

DISCUSSION

Prevalence of PA. In previous studies, the proportion of community-dwelling elderly with PA was 10%–25% when evaluated using the CNAQ or the Simplified Nutritional Appetite Questionnaire (SNAQ), while that of individuals in need of nursing support/care, outpatients, or hospitalized patients was 20%–45% (21-24). The prevalence of PA was 38.0% in this population. These figures suggest that elderly people who need nursing support and/or medical care are at higher risk of PA.

Anthropometric characteristics. Some studies have demonstrated associations of appetite with age and several anthropometric parameters, including BMI, skeletal muscle mass, calf circumference, and grip strength, in the elderly (25-27); however, the observed associations were not universal or consistent. In this study, we found a significant association of appetite with only calf circumference. These inconsistencies may be due in part to the different backgrounds of the study populations and the fact that physical changes occur as a result of persistent loss of appetite.

Living status. Similar to the present study, there have been some studies examining associations between eating alone and/or living alone and decreased appetite (27,28). Other studies have demonstrated that living alone and/or eating alone was associated with reduced consumption of energy, nutrients and certain food items and with malnutrition (29-31). Thus, living alone and/or eating alone can be considered a risk factor for PA or malnutrition in the elderly. The prevalence of living alone (36.6%) was greater in our participants than in the general population. Approximately 6.24 million people (26.3%) aged 65 years or over were living alone in Japan in 2015 (32). Given that elderly persons living alone have been increasing both in number and in proportion, careful attention should be paid to their appetite.

Mental health. The prevalence of depression of approximately 41% in the present study was greater than the range of 10%–30% previously reported for the elderly without functional impairment (21,33,34) but similar to the range of 30%–65% reported in the elderly living in nursing homes (7,21,35), suggesting that elderly people who

need nursing support/care are at higher risk of depression. Relevant studies have found that depression was significantly related to PA/anorexia and malnutrition in the elderly living in the community and in nursing homes (7,21,34), as seen in the present study.

Although some studies have demonstrated an association of PA/anorexia with QOL in patients with cancer (36-38), there is limited information on this relationship in the community-dwelling elderly or those who need nursing support/care. Acar Tek *et al*. reported that appetite was associated with mental and physical components of health-related QOL (39). There were no published observations on the relationship between the PGC-MS score and appetite in the elderly who need nursing support/care, whereas we noted that PGC-MS score was lower in the PA group than in the GA group. Therefore, it seems worthwhile to further investigate associations between PA/anorexia and QOL.

Dietary and nutritional status. Using the SNAQ and a 24-hour dietary recall survey, Hara *et al.* demonstrated significantly lower intakes of energy, protein, lipids, carbohydrates, dietary fibers, iron, and zinc, but not of calcium or sodium, in elderly outpatients with PA/anorexia compared with their counterparts without PA/anorexia in Brazil (24). van der Meij *et al*. administered a food frequency questionnaire to a group of community-dwelling elderly in the Netherlands and found lower intakes of protein and dietary fibers in individuals with PA than in those with GA/very GA (40). Payette *et al*. also reported associations of appetite with intakes of energy and protein in an elderly Canadian population receiving publicly funded home care packages (41).

Hara *et al.* reported that outpatients with anorexia had inadequate intakes of 87.7% for energy and 71.5% for protein: that is, they were below 30 kcal/kg (body weight) for energy and below 1 g/kg for protein according to the values recommended in the European Society for Clinical Nutrition and Metabolism guideline (24,42). Payette *et al.* found that 78% of elderly men and 70% of women had insufficient energy intakes, and 57% of elderly men and 80% of women did not meet the recommended protein consumption per day (0.8 g/kg) according to the advised nutrient intake for Canadians (41,43). In the present study, 62.5% of the PA group had insufficient energy consumption as defined by the Dietary Reference Intakes for Japanese. Median values for protein consumption per body weight and standard body weight in the PA group were under 1 g/kg, while those in the GA groups were over 1 g/kg, suggesting more than half of the PA group had insufficient protein intake. Given that the participants in the above-mentioned studies (24,40,41) had varied background characteristics and different criteria were used to determine insufficient dietary intake, a direct inter-comparison could not be made; however, it seemed obvious that participants with PA had lower/inadequate consumption of energy and protein than those with GA.

In Italy, Donini *et al*. reported that elderly participants with anorexia (in community-dwelling individuals aged ≥65 years, nursing home residents, patients in rehabilitation and emergency wards) had reduced intake in certain food groups including meat, eggs, fish, fruits and vegetables (44). van der Meij *et al*. also reported that their participants with PA had significantly decreased consumption of solid food, protein-rich food, whole grains, fruits and vegetables, but increased consumption of dairy food, oils and fats, sweets, and sodas when compared with those with GA (40). Our study also noted that PA was associated with lower or inadequate intake of various food items and nutrients in elderly population attending a day-care facility. All the aforementioned studies demonstrated that PA was strongly related to reduced intakes of crucial nutrients (including energy and protein) and relevant food items. In other words, it appeared that elderly people with PA were at risk of undernutrition or malnutrition.

Binary logistic regression. A multivariate binary logistic regression noted that PA was associated with reduced consumption of protein and living alone in the present study. We also detected a strong correlation between intakes of energy and protein (r=0.907). These results were compatible with the findings by Payette *et al.* (41), showing an association between decreased energy consumption and PA. Accordingly, consumption of nutrients (energy and protein, in particular) and living status seemed important factors of PA in elderly people.

Limitations. The main limitation of this study was its lack of statistical power because of a small study population. It had a cross-sectional design, which precluded investigation of cause-and-effect relationships and the risk of PA. Furthermore, because this study was conducted in a day-care facility, it appears unclear whether the findings could be generalized to other elderly populations.

Conclusions. We identified 38% prevalence of PA at a day-care facility in Japan. PA in this population was significantly associated with living alone and reduced protein intake and tended to be associated with depression. Given that nutritional intervention would generally be implemented after the onset of weight loss or undernutrition, assessment of appetite and related factors in the elderly should be of high priority to prevent undernutrition or malnutrition.

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CONFLICTS OF INTEREST

The authors have no conflicts of interest to declare.

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