Association between dietary variety status and sarcopenia as defined by the Asian Working Group for Sarcopenia 2019 consensus in older outpatients at a hospital specializing in geriatric medicine: A cross-sectional study with baseline data of prospective cohort study (JUSTICE-TOKYO study)

DAISUKE ASAOKA[1], KOJI SUGANO[2], KEI MATSUNO[2], NOBUTO SHIBATA[3], HIDEKI SUGIYAMA[3], NOEMI ENDO[3], YOSHIYUKI IWASE[4], MIYUKI TAJIMA[5], NAOKO SAKUMA[5], MEGUMI INOUE[5], MARIKO NAGATA[5], TAEKO MIZUTANI[6], MIZUKI ISHII[6], SACHI IIDA[6], YOSHIKO MIURA[7], YUJI NISHIZAKI[8], NAOTAKE YANAGISAWA[8], AKIHITO NAGAHARA[9] and KATSUMI MIYAUCHI[10]

[1]Department of Gastroenterology, Juntendo Tokyo Koto Geriatric Medical Center, Shinsuna, Koto, Tokyo 1360075, Japan; [2]Department of Respiratory Medicine, Juntendo Tokyo Koto Geriatric Medical Center, Shinsuna, Koto, Tokyo 1360075, Japan; [3]Department of Psychiatry, Juntendo Tokyo Koto Geriatric Medical Center, Shinsuna, Koto, Tokyo 1360075, Japan; [4]Department of Orthopedic Surgery, Juntendo Tokyo Koto Geriatric Medical Center, Shinsuna, Koto, Tokyo 1360075, Japan; [5]Department of Pharmacy, Juntendo Tokyo Koto Geriatric Medical Center, Shinsuna, Koto, Tokyo 1360075, Japan; [6]Department of Nursing, Juntendo Tokyo Koto Geriatric Medical Center, Shinsuna, Koto, Tokyo 1360075, Japan; [7]Department of Nutrition, Juntendo Tokyo Koto Geriatric Medical Center, Shinsuna, Koto, Tokyo 1360075, Japan; [8]Medical Technology Innovation Center, Juntendo University, Hongo, Bunkyo, Tokyo 1138421, Japan; [9]Department of Gastroenterology, Juntendo University School of Medicine, Hongo, Bunkyo, Tokyo 1138421, Japan; [10]Department of Cardiology, Juntendo Tokyo Koto Geriatric Medical Center, Shinsuna, Koto, Tokyo 1360075, Japan

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Abstract. To the best of our knowledge, little is known about the association between dietary variety status and sarcopenia in university-affiliated geriatric hospital in elderly. The present study aimed to investigate, in a multidisciplinary setting, the prevalence of sarcopenia and association between dietary variety status and sarcopenia in older outpatients at Juntendo Tokyo Koto Geriatric Medical Center (Tokyo, Japan). Between October 2020 and December 2021, a cross-sectional study of outpatients aged ≥65 years [458 male (44%) and 584 female (56%); mean age, 78.2±6.1 years] was conducted to assess prevalence of sarcopenia, according to Asian Working Group for Sarcopenia 2019 criteria, and the relationship between dietary variety status and sarcopenia. Patient profile, comorbidities, drug use, neuropsychological data, abdominal symptoms, pulmonary function and dietary variety status were collected. Of 1,042 subjects, there were 223 (21.4%) with [142 male (63.7%) and 81 female (36.3%); mean age, 80.6±6.3 years] and 819 (78.6%) without sarcopenia [316 male (38.6%) and 503 female (61.4%); mean age, 77.6±5.8]. In multivariate analysis, older age, male sex, low body mass index, high Brinkman Index and phase angle, low quality of life, history of daycare use, diabetes mellitus, osteoporosis and low Mini-Mental State Examination and Dietary Variety Score were related to sarcopenia. The prevalence of sarcopenia was higher in than in community-dwelling individuals. Dietary variety status was associated with sarcopenia.

Correspondence to: Dr Daisuke Asaoka, Department of Gastroenterology, Juntendo Tokyo Koto Geriatric Medical Center, 3-3-20 Shinsuna, Koto, Tokyo 1360075, Japan
E-mail: daisuke@juntendo.ac.jp

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Introduction

Defined as loss of skeletal muscle mass in old age, sarcopenia is associated with a risk of physical disability, decreased quality of life (QOL) and increased mortality (1). In Japan, because the population is rapidly aging, sarcopenia is an important consideration when contemplating measures to increase the healthy longevity of older people and prevent requirements for nursing care. According to meta-analysis (2), the sarcopenia prevalence in individuals aged >60 years depends on the set of classification criteria used as follows: European Working Group on Sarcopenia in Older People 2 (EWGSOP) 2, 10; EWGSOP, 23; AWGS (the Asian Working Group for Sarcopenia), 14; International Working Group

on Sarcopenia, 14; Foundation for the National Institutes of Health, 12 and muscle mass definition, 27%, respectively. The Asian Working Group for Sarcopenia (AWGS) was established in 2014 (3) and renamed the AWGS 2019 Consensus. Several studies have reported that sarcopenia prevalence ranges from 7 to 8% (4,5) in Asian countries, but varies widely across study design, population and settings. To the best of our knowledge, few previous reports have focused on the association between dietary variety status and sarcopenia in older outpatients at a university-affiliated geriatric hospital in Japan (6).

The aim of this study was to investigate, in a multidisciplinary context, the prevalence of AWGS 2019 consensus-defined sarcopenia and its association with dietary variety status in older outpatients at a university-affiliated geriatric hospital.

Materials and methods

Study design. The present single-center, cross-sectional study used the baseline data of prospective cohort study Juntendo Sarcopenia Registration of Exploring for Predictors and Prognosis in the elderly in Tokyo (JUSTICE-TOKYO) (7), in accordance with the guidelines contained in the STROBE Checklist (8).

The JUSTICE-TOKYO study is a prospective, observational cohort study of consecutive outpatients aged ≥65 years attending Juntendo Tokyo Koto Geriatric Medical Center, Tokyo, Japan. The study enrolled 1,042 patients between November 2020 and November 2021 and will be completed in 2025. The participants will be followed up annually for 4 years after enrollment to determine survival, incidence of falls, number of hospitalizations and skeletal muscle mass. At enrollment, baseline data including patient profile [age, body mass index (BMI), Brinkman Index (BI), drinking habits, sex, history of falls, daycare use, social frailty, phase angle (PhA) and QOL], comorbidities, questionnaires [Mini-Mental State Examination (MMSE), Geriatric Depression Scale 15 (GDS-15), Abdominal symptom-related QOL (Izumo scale) scores, constipation scoring system (CSS), chronic obstructive pulmonary disease (COPD) assessment test (CAT)] (9-13), physical and skeletal muscle mass, physiological function test and nutritional assessment data were collected and entered prospectively into the Research Electronic Data Capture system, which provides web-based software for the creation of secure online forms (14).

Exclusion criteria. Patients were excluded for the following reasons: i) Inability to walk independently because of severe osteoarthritis or neuromuscular disease, ii) immobility, iii) delirium tremens at presentation, iv) history of gastrointestinal, renal, acute cerebrovascular, coronary, hepatic and respiratory events, v) inability to be interviewed by questionnaire and vi) predicted life expectancy <1 year because of malignant disease.

Research instruments. Inclusion was limited to patients whose information at registration included all of the following:

i) Age, body mass index (BMI), Brinkman Index (BI) (15), drinking habits (0, rarely drinks alcohol; 1, drinks alcohol 1-4 days/week and 2, drinks alcohol 5-7 days/week), sex, history of falls and daycare use, social frailty, phase angle (PhA) and quality of life assessed by EuroQol Visual Analogue Scale (EQ-VAS) (16-18). Social frailty was assessed using questions regarding living alone, going out less frequently compared with the prior year, visiting friends sometimes, feeling helpful to friends or family and talking with someone every day. Resistances to a multi-frequency alternating current applied to the trunk, arms and legs were measured to determine body composition and impedance characteristics, including capacitive reactance and PhA, were analyzed by an MC-780A body composition analyzer (TANITA Corporation). PhA was calculated as follows: [- arc tangent (reactance/resistance) x180°/π] (19). PhA represents resistance of the cell membrane, the volume of somatic cells and the distribution of intra- and extracellular fluid; higher PhA generally indicates good cell health, while lower value of PhA reflects structural damage to the cell membrane and decreased cell density, indicating poor cell function (20). Dual-energy X-ray Absorptiometry) standard method for measuring an appendicular skeletal muscle mass in sarcopenia was used (21). PhA cannot be measured by the DXA method but can be measured by the BIA (Bioelectrical Impedance Analysis) method to investigate whether PhA is associated with sarcopenia in older outpatients (22). QOL was evaluated by EQ-VAS (0=worst health, 100=perfect health), commonly used in primary care. Anthropocentric measures, physiological performance test, walking speed, and various questionnaires [(Izumo scale), constipation scoring system (CSS), chronic obstructive pulmonary disease (COPD) assessment test (CAT), Dietary Variety Score (DVS)] (11-13,23) were conducted by nurses and nutritionists.

ii) Comorbidities [history of atrial fibrillation, cerebral infarction/hemorrhage, diabetes mellitus (DM), hospitalization for heart failure, hypertension, interstitial pneumonia, malignant disease, myocardial infarction and osteoporosis]. The age-adjusted Charlson comorbidity index was calculated for each patient (24,25). T-score and young adult mean (YAM) % were measured by DXA of the total hip and lumbar spine (L2-L4). Prodigy Advance scanner (GE Healthcare) was used to perform DXA. Osteoporosis was diagnosed in accordance with Japanese Society for Bone and Mineral Research criteria (26).

iii) Use of therapeutic agents (statins, acid secretion suppressants, laxatives, steroids, analgesics, antidementia drugs, antipsychotic drugs) and number of oral medicines. Data on medications and number of oral medicines were obtained by pharmacists from patient health notebooks.

iv) Neuropsychological examinations [Geriatric Depression Scale 15 (GDS-15) and Mini-Mental State Examination (MMSE)] (9,10) were performed by psychiatrists.

v) Abdominal symptom-related QOL (Izumo scale) scores (constipation-, diarrhea-, fullness-, reflux- and upper abdominal pain-related QOL) (11). QOL impairment was ranked from 0 (no impairment) to 15 (symptomatic).

vi) Severity of constipation was rated using the constipation scoring system (CSS) (12), comprised of eight items: Abdominal pain, assistance for evacuation, duration of constipation, frequency of bowel movements, incomplete evacuation, length of time/attempt, number of unsuccessful attempts at evacuation/24 h and painful evacuation. The overall CSS score, which is the sum of the item scores, ranged from 0 to 30, with a higher score signifying constipation symptoms were worse. Gastroenterologists performed the constipation severity assessments using CSS and Izumo scales.

vii) Pulmonary function data [arterial oxygen saturation (SpO_2), chronic obstructive pulmonary disease (COPD) assessment test (CAT)] results, restricted and obstructive ventilatory impairment) (13,27). The 8-item CAT was used to assess the impact of COPD on health status. CAT score ≥10 indicated a high symptomatic level. Pulmonary function tests including vital capacity (VC), forced VC (FVC) and forced expiratory volume in 1 sec (FEV1) were performed on a Minato System 21 (Minato Medical Science Co., Ltd.). The pulmonary function tests, CAT and eating assessment test 10 (EAT10) (28) were evaluated by a respiratory physician.

viii) Nutritional status [hypozincemia, controlling nutritional status (CONUT) score, DVS)] (23,29). Hypozincemia was defined as requiring treatment with zinc acetate hydrate (Novelzin® Tablets, Nobelpharma K.K.) or serum zinc levels <80 μg/dl. Zinc is a trace element essential for life. Appetite loss (30), depression (31), and taste abnormality (32) are hypozincemia-associated symptoms and risk factors for hypoalimentation. CONUT score (0-12; calculated from serum albumin and total cholesterol levels and total lymphocyte count) (29) was used to measure objective nutritional status. Comprising 10 food-based components (23), DVS was calculated as follows. First, consumption frequencies during 1 week were determined for each of 10 food items (meat, fish/shellfish, eggs, milk, soybean products, green/yellow vegetables, potatoes, fruit, seaweed and fats/oils). Second, scores were assigned as follows: 1, eaten almost daily and 0, not eaten almost daily. Third, the item scores were summed and the total DVS was in the range 0 to 10, with higher scores indicating greater dietary variety.

ix) Oral function [Oral Frailty Index (OFI)-8 and EAT10] (28,33). Oral frailty was defined as OFI-8 score ≥4. The EAT10 tool was used to assess dysphagia severity. The data were collected within 3 months after registration.

Definition of sarcopenia. Diagnostic algorithm recommended by AWGS 2019 Consensus was used to define (21). The handgrip strength was measured twice each with both hands using a handgrip dynamometer (Toei Light Co., Ltd.), and the larger value was noted as the maximum muscle strength. Low grip strength was defined as <28 for male and <18 kg for female patients, according to AWGS criteria. Gait speed, manually assessed using a stopwatch, was defined as slow when <1.0 m/sec according to AWGS criteria. Lean mass and regional fat were assessed from whole-body DXA scans (Prodigy Advance, GE Healthcare). Subjects were positioned for whole-body scans in accordance with the manufacturer's protocol. The whole-body fat mass and lean mass were divided into arms, legs and trunk. The appendicular lean mass was estimated as the sum of the lean mass of the upper and lower limbs. The appendicular skeletal muscle mass index (SMI) was calculated as the appendicular lean mass divided by the square of the height (34). A low appendicular skeletal muscle mass was defined as appendicular SMI <7.0 in male and <5.4 kg/m^2 in female patients.

Statistical analysis. Subjects were divided into sarcopenia and non-sarcopenia groups and risk factors for sarcopenia were compared by uni- and multivariate analyses. Quantitative data are expressed as mean ± standard deviation. In univariate analyses, χ^2 test was used for categorical variables and unpaired Student t tests were used for continuous variables. Independent variables with P<0.20 in the univariate analysis were included in multivariate logistic regression analysis. The odds ratio (OR) and 95% confidence interval (CI) were used to assess the strength of any associations. All statistical analyses were performed using the SPSS version 28 software (IBM Corporation). P<0.05 was considered to indicate a statistically significant difference.

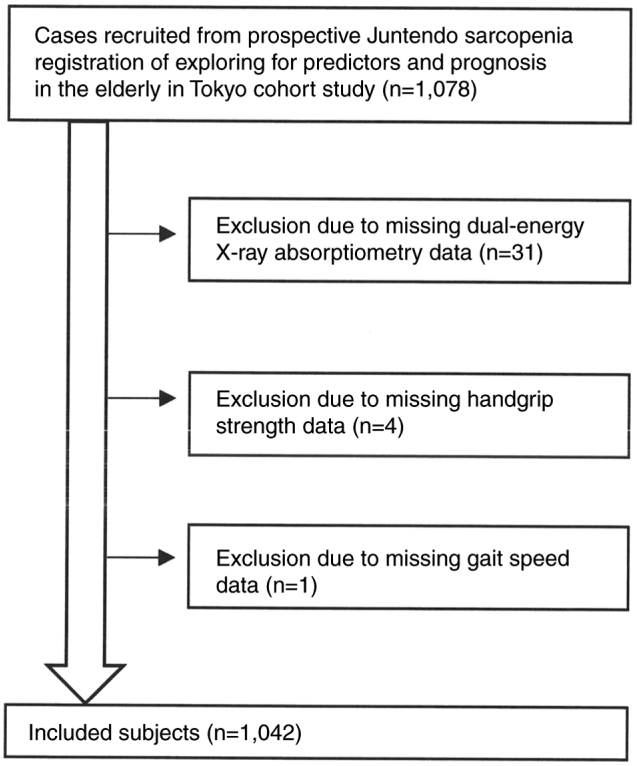

Figure 1. Participant recruitment. DXA, dual-energy X-ray Absorptiometry.

Results

Clinical characteristics of patients. The clinical characteristics are summarized in Table I. Participant recruitment flow diagram is shown in Fig. 1. Mean age-adjusted Charlson Comorbidity Index score was 5.5±1.4. Sex- and age-specific prevalence of sarcopenia is shown in Table II. Sarcopenia and non-sarcopenia were diagnosed in 223 and 819 patients, respectively. The total prevalence of sarcopenia was 31.0 in male and 13.9% in female patients.

Association between sarcopenia and covariates in univariate analysis. Table III shows the association between sarcopenia and covariates in univariate analysis and the prevalence of sarcopenia. Between the sarcopenia and non-sarcopenia groups, there were significant differences in age, BMI, Brinkman Index, cerebral infarction/hemorrhage, history of falls and daycare use, myocardial infarction, number of oral medicines, PhA, proportion of males, QOL, history of hospitalization for heart failure, malignant disease and diabetes mellitus, age-adjusted Charlson comorbidity index, use of antidementia drugs, number of oral medicines, MMSE,

Table I. Clinical characteristics of participants (n=1,042).

Characteristic	Value
Mean age, years	78.2±6.1
Sex (%)	
Male	458 (44.0)
Female	584 (56.0)
Mean BMI, kg/m^2	22.9±3.9
Mean Brinkman Index	359.1±615.5
Mean alcohol	0.5±0.8
Mean phase angle, °	-4.7±0.8
Mean EQ-5D score	75.0±17.0
History of falls (%)	
Yes	203 (19.5)
No	839 (80.5)
History of daycare use (%)	
Yes	91 (8.7)
No	951 (91.3)
Social frailty (%)	
Yes	679 (65.2)
No	363 (34.8)
Cerebral infarction/hemorrhage (%)	
Yes	79 (7.6)
No	963 (92.4)
Myocardial infarction (%)	
Yes	44 (4.2)
No	998 (95.8)
Hospitalization for heart failure (%)	
Yes	41 (3.9)
No	1,001 (96.1)
Interstitial pneumonia (%)	
Yes	54 (5.2)
No	988 (94.8)
Malignant disease (%)	
Yes	228 (21.9)
No	814 (78.1)
Hypertension (%)	
Yes	606 (58.2)
No	436 (41.8)
Diabetes mellitus (%)	
Yes	180 (17.3)
No	862 (82.7)
Atrial fibrillation (%)	
Yes	87 (8.3)
No	955 (91.7)
Osteoporosis (%)	
Yes	343 (32.9)
No	699 (67.1)
Mean age-adjusted Charlson comorbidity index	5.5±1.4
Statin use (%)	
Yes	434 (41.7)
No	608 (58.3)

Table I. Continued.

Characteristic	Value
Acid secretion suppressant use (%)	
Yes	573 (55.0)
No	469 (45.0)
Laxative use (%)	
Yes	228 (21.9)
No	814 (78.1)
Steroid use (%)	
Yes	50 (4.8)
No	992 (95.2)
Analgesic drug use (%)	
Yes	114 (10.9)
No	928 (89.1)
Antidementia drug use (%)	
Yes	29 (2.8)
No	1013 (97.2)
Antipsychotic drug use (%)	
Yes	261 (25.0)
No	781 (75.0)
Mean number of oral medicines	6.1±3.5
Mean MMSE score	26.5±3.1
Mean GDS-15 score	4.2±3.0
Mean reflux-related QOL score	1.8±2.4
Mean upper abdominal pain-related QOL score	1.1±2.0
Mean fullness-related QOL score	1.6±2.4
Mean constipation-related QOL score	2.2±2.6
Mean diarrhea-related QOL score	2.0±2.6
Mean CSS score	3.5±3.7
Mean SpO_2,%	97.2±2.1
Mean CAT score	8.5±6.6
Restricted ventilatory impairment (%)	
Yes	172 (16.5)
No	870 (83.5)
Obstructive ventilatory impairment (%)	
Yes	260 (25.0)
No	782 (75.0)
Hypozincemia (%)	
Yes	820 (78.7)
No	222 (21.3)
Mean CONUT score	1.0±1.1
Mean DVS	3.7±2.2
Oral frailty (%)	
Yes	522 (50.1)
No	520 (49.9)
Mean EAT10 score	1.6±3.7

EQ-5D, EuroQol-5Dimention; MMSE, Mini-Mental State Examination; GDS-15, Geriatric Depression Scale 15; QOL, quality of life; CSS, constipation scoring system; SpO2, saturation of percutaneous oxygen; CAT, chronic obstructive pulmonary disease (COPD) assessment test; CONUT, controlling nutritional status; DVS, Dietary Variety Score; EAT10, eating assessment test 10.

Table II. Prevalence of sarcopenia.

A, Total (n=1,042)

Age, years	Number of patients	Number of cases	Prevalence, %
65-69	85	15	17.6
70-74	231	33	14.3
75-79	278	38	13.7
80-84	274	70	25.5
≥85	174	67	38.5

B, Male (n=458)

Age, years	Number of patients	Number of cases	Prevalence, %
65-69	42	11	26.2
70-74	94	14	14.9
75-79	123	23	18.7
80-84	113	47	41.6
≥85	86	47	54.7

C, Female (n=584)

Age, years	Number of patients	Number of cases	Prevalence, %
65-69	43	4	9.3
70-74	137	19	13.9
75-79	155	15	9.7
80-84	161	23	14.3
≥85	88	20	22.7

GDS-15, reflux-related QOL and CSS score, restricted ventilatory impairment, CONUT score, DVS, oral frailty and EAT10 score.

Association between sarcopenia and covariates in multivariate analysis. In multivariate analysis, age, male sex, BMI, Brinkman Index, PhA, QOL, history of daycare use, diabetes mellitus, osteoporosis, MMSE and DVS were related to sarcopenia (Table IV).

Discussion

To the best of our knowledge, the present study is the first large cross-sectional, multidisciplinary study examining the prevalence of sarcopenia according to AWGS 2019 consensus criteria and the association between dietary variety status and sarcopenia in older outpatients of a university-affiliated geriatric hospital in Japan. Sarcopenia prevalence was higher than previously reported in community-dwelling individuals (2) and dietary variety status was associated with sarcopenia.

According to a systematic review and meta-analysis, muscle mass is most commonly assessed by BIA, followed by DXA and computed tomography scan (35). The most frequently employed sarcopenia classification criteria established by the European Working Group on Sarcopenia in Older People (EWGSOP) (36) and AWGS, were used in 95 and 55 studies, respectively (31). According to the aforementioned meta-analysis, the sarcopenia prevalence in individuals aged >60 years depended on the set of classification criteria used as follows: EWGSOP2, 10; EWGSOP, 23; AWGS, 14; International Working Group on Sarcopenia, 14; Foundation for the National Institutes of Health, 12 and muscle mass definition, 27%, respectively. Here, sarcopenia prevalence was higher (21.4%) than the mean of the reported prevalence of AWGS-defined sarcopenia (2). This discrepancy may be attributed to the higher number of patients with multiple severe disease at a university-affiliated geriatric hospital. Additionally, the mean age of participants was higher in here (78.2±6.1 years) than in other studies (71-74 years) (37-40). In a prospective study of the relationship between sarcopenia and falls in persons aged ≥80 years (mean age, 86.7 years) in Italy, sarcopenia was identified in 25.4% of participants (41). Hence, interpretation of sarcopenia prevalence should consider diagnostic criteria used and the characteristics of the population under study (37-41).

The present study showed a higher prevalence of sarcopenia among male compared with female patients. However, a meta-analysis of studies using the AWGS definition did not find a difference in the sarcopenia prevalence based on sex (2). Participants in the present study were all outpatients

Table III. Association between sarcopenia and covariates in univariate analysis.

Covariate	Sarcopenia (n=223)	Non-sarcopenia (n=819)	P-value
Mean age, years	80.6±6.3	77.6±5.8	<0.001
Sex (%)			
Male	142 (63.7)	316 (38.6)	
Female	81 (36.3)	503 (61.4)	<0.001
Mean BMI, kg/m^2	20.8±3.1	23.4±3.9	<0.001
Mean Brinkman Index	543.0±309.0	309.0±568.9	<0.001
Mean alcohol	0.5±0.5	0.5±0.8	0.366
Mean phase angle, °	-4.4±0.9	-4.8±0.8	<0.001
Mean EQ-5D score	71.6±17.5	76.0±16.7	<0.001
History of falls (%)			
Yes	54 (24.2)	149 (18.2)	
No	169 (75.8)	670 (81.8)	0.044
History of daycare use (%)			
Yes	36 (16.1)	55 (6.7)	
No	187 (83.9)	764 (93.3)	<0.001
Social frailty (%)			
Yes	155 (69.5)	524 (64.0)	
No	68 (30.5)	295 (36.0)	0.125
Cerebral infarction/hemorrhage (%)			
Yes	26 (11.7)	53 (6.5)	
No	197 (88.3)	766 (93.5)	0.009
Myocardial infarction (%)			
Yes	16 (7.2)	28 (3.4)	
No	207 (92.8)	791 (96.6)	0.013
Hospitalization for heart failure (%)			
Yes	14 (6.3)	27 (3.3)	
No	209 (93.7)	792 (96.7)	0.042
Interstitial pneumonia (%)			
Yes	17 (7.6)	37 (4.5)	
No	206 (92.4)	782 (95.5)	0.064
Malignant disease (%)			
Yes	63 (28.3)	165 (20.1)	
No	160 (71.7)	654 (79.9)	0.009
Hypertension (%)			
Yes	140 (62.8)	466 (56.9)	
No	83 (37.2)	353 (43.1)	0.114
Diabetes mellitus (%)			
Yes	58 (26.0)	122 (14.9)	
No	165 (74.0)	697 (85.1)	<0.001
Atrial fibrillation (%)			
Yes	21 (9.4)	66 (8.1)	
No	202 (90.6)	753 (91.9)	0.516
Osteoporosis (%)			
Yes	83 (37.2)	260 (31.7)	
No	140 (62.8)	559 (68.3)	0.125
Mean age-adjusted Charlson comorbidity index	6.1±1.5	5.4±1.4	<0.001
Statin use (%)			
Yes	86 (38.6)	348 (42.5)	
No	137 (61.4)	471 (57.5)	0.292

Table III. Continued.

Covariate	Sarcopenia (n=223)	Non-sarcopenia (n=819)	P-value
Acid secretion suppressant use (%)			
Yes	127 (57.0)	446 (54.5)	
No	96 (43.0)	373 (45.5)	0.507
Laxative use (%)			
Yes	55 (24.7)	173 (21.1)	
No	168 (75.3)	646 (78.9)	0.257
Steroid use (%)			
Yes	12 (5.4)	38 (4.6)	
No	211 (94.6)	781 (95.4)	0.646
Analgesic drug use (%)			
Yes	22 (9.9)	92 (11.2)	
No	201 (90.1)	727 (88.8)	0.562
Antidementia drug use (%)			
Yes	11 (4.9)	18 (2.2)	
No	212 (95.1)	801 (97.8)	0.0278
Antipsychotic drug use (%)			
Yes	57 (25.6)	204 (24.9)	
No	166 (74.4)	615 (75.1)	0.842
Mean number of oral medicines	6.8±3.6	6.0±3.5	0.002
Mean MMSE score	25.3±3.5	26.8±2.9	<0.001
Mean GDS-15 score	5.0±3.2	4.0±3.0	<0.001
Mean reflux-related QOL score	1.5±2.1	1.8±2.4	0.030
Mean upper abdominal pain-related QOL score	1.0±2.1	1.1±2.0	0.652
Mean fullness-related QOL score	1.6±2.5	1.7±2.4	0.804
Mean constipation-related QOL score	2.3±2.8	2.2±2.5	0.616
Mean diarrhea-related QOL score	2.2±2.9	2.0±2.5	0.375
Mean CSS score	4.0±4.1	3.3±3.6	0.013
Mean SpO_2 (%)	97.0±4.0	97.3±1.1	0.156
Mean CAT score	9.1±6.9	8.4±6.5	0.118
Restricted ventilatory impairment (%)			
Yes	60 (26.9)	112 (13.7)	
No	163 (73.1)	707 (86.3)	<0.001
Obstructive ventilatory impairment (%)			
Yes	66 (29.6)	194 (23.7)	
No	157 (70.4)	625 (76.3)	0.071
Hypozincemia (%)			
Yes	186 (83.4)	634 (77.4)	
No	37 (16.6)	185 (22.6)	0.053
Mean CONUT score	1.4±1.3	0.9±1.1	<0.001
Mean DVS	3.3±2.3	3.8±2.2	<0.001
Oral frailty (%)			
Yes	127 (57.0)	395 (48.2)	
No	96 (43.0)	424 (51.8)	0.021
Mean EAT10 score	2.2±4.2	1.4±3.5	0.004

EQ-5D, EuroQol-5Dimention; MMSE, Mini-Mental State Examination; GDS-15, Geriatric Depression Scale 15; QOL, quality of life; CSS, constipation scoring system; SpO2, saturation of percutaneous oxygen; CAT, chronic obstructive pulmonary disease (COPD) assessment test; CONUT, controlling nutritional status; DVS, Dietary Variety Score; EAT10, eating assessment test 10.

Table IV. Association between sarcopenia and covariates in multivariate analysis.

Covariate	Standardized coefficient	OR	95% CI	P-value
Age	0.061	1.0632	1.028-1.100	<0.001
Male	1.903	6.7028	3.818-11.767	<0.001
BMI	-0.272	0.7619	0.715-0.812	<0.001
Brinkman Index	0.000	1.0004	1.000-1.001	0.021
Phase angle	0.619	1.8576	1.385-2.491	<0.001
EQ-5D	-0.015	0.9853	0.975-0.996	0.007
History of falls	0.242	1.2735	0.789-2.057	0.323
History of day care use	0.646	1.9071	1.038-3.504	0.038
Social frailty	0.230	1.2583	0.822-1.927	0.291
Cerebral infarction/hemorrhage	0.209	1.2322	0.600-2.530	0.569
Myocardial infarction	0.515	1.6733	0.725-3.860	0.227
History of hospitalization for heart failure	0.382	1.4649	0.523-4.102	0.467
Interstitial pneumonia	0.504	1.6555	0.764-3.587	0.201
Malignant disease	0.188	1.2067	0.773-1.884	0.409
Hypertension	0.174	1.1902	0.786-1.802	0.411
Diabetes mellitus	0.780	2.1823	1.381-3.449	0.001
Osteoporosis	0.595	1.8130	1.078-3.048	0.025
Age-adjusted Charlson comorbidity index	-0.019	0.9814	0.707-1.362	0.910
Antidementia drug use	-0.573	0.5638	0.141-2.256	0.418
Number of oral medicines	0.013	1.0130	0.953-1.077	0.678
MMSE score	-0.085	0.9184	0.862-0.978	0.008
GDS-15 score	0.045	1.0459	0.981-1.115	0.171
Reflux-related QOL score	-0.053	0.9480	0.867-1.036	0.240
CSS score	-0.003	0.9974	0.946-1.051	0.922
SpO_2	0.021	1.0214	0.955-1.093	0.538
CAT score	0.004	1.0043	0.968-1.042	0.816
Restricted ventilatory impairment	0.238	1.2692	0.787-2.048	0.329
Obstructive ventilatory impairment	0.143	1.1540	0.747-1.783	0.519
Hypozincemia	-0.364	0.6950	0.432-1.119	0.134
CONUT score	-0.015	0.9851	0.835-1.162	0.859
DVS	-0.092	0.9120	0.834-0.997	0.043
Oral frailty	0.043	1.0436	0.690-1.578	0.840
EAT10 score	-0.005	0.9949	0.943-1.049	0.850

EQ-5D, EuroQol-5Dimention; MMSE, Mini-Mental State Examination; GDS-15, Geriatric Depression Scale 15; QOL, quality of life; CSS, constipation scoring system; SpO2, saturation of percutaneous oxygen; CAT, chronic obstructive pulmonary disease assessment test; CONUT, controlling nutritional status; DVS, Dietary Variety Score; EAT10, eating assessment test 10.

at a university-affiliated geriatric hospital. This resulted in a higher mean age compared with previously reported community-dwelling older populations (2). Since a previous Japanese cohort study showed that sarcopenia prevalence increases with age in males (37), the higher mean age may underlie the present high sarcopenia prevalence among males.

In the present study, sarcopenia was significantly associated with Brinkman Index, history of daycare use, PhA, QOL and DM. Previous reports indicate a higher prevalence of smokers in male patients with sarcopenia (38) although the association is not confirmed (40). Because PhA reflects cell membrane fragility, muscle mass and strength and nutritional status, its use as a proxy for predicting falls and identifying individuals at risk of disability has been suggested (42). Matsumoto *et al* (43) demonstrated that a history of falls may serve as a simple screening tool to help prevent osteoporosis and sarcopenia. A 2-year prospective observational study indicated that sarcopenia prevalence is a significant predictor of falling (44). In older adults, injuries and fractures from falls lead to reduced physical activity and strength and confinement to bed (38,39). PhA from BIA is a valuable and simple prognostic tool for identifying older individuals at risk of disability who may benefit from preventive treatment (45). The present study also evaluated quality of life using the EQ-VAS questionnaire, which is commonly used in primary care to assess health. Previous studies have demonstrated the value of EQ-VAS in assessing frailty and decline in EQ-VAS in predicting frailty (46,47). DM and heart failure are risk factors

for skeletal muscle mass decrease (48,49). Studying sarcopenia and its association with DM and heart failure may provide insight into sarcopenia prevention, diagnosis and management.

The present study also showed that osteoporosis and sarcopenia are significantly associated. Hida *et al* (50) suggested that sarcopenia increases the risk for osteoporotic vertebral fracture. Simultaneous muscle loss and abnormal bone metabolism caused by sarcopenia-associated systemic disorder, including malnutrition and diabetes, could contribute to this association (50). Neuropsychological examination in the present study revealed that sarcopenia was associated with low MMSE and high GDS-15 score. Several studies have suggested that cognitive impairment is associated with sarcopenia (38,51,52). Nishikawa *et al* (53) reported an independent association between decreased grip strength and increased risk for depression progression in patients with chronic liver disease.

A systematic review conducted by Jang *et al* (54) concluded that dietary variety can decrease risk of sarcopenia. The present study found a significant association CSS and sarcopenia in univariate analysis. A previous study in Juntendo Tokyo Koto Geriatric Medical Center, Tokyo, Japan) demonstrated that sarcopenia is an independent predictor for CSS score (55). Decreased abdominal pressure due to low muscle mass for sarcopenia may contribute to functional defecation disorder (49). DVS was associated with sarcopenia. Momoki *et al* reported that DVS is associated with sarcopenia in elderly female community residents in Japan (56).

The present study had limitations. First, participants were outpatients aged ≥65 years at a single university hospital. Background variables such as exercise routines, dietary pattern, occupation, education level and marital status was not investigated. Therefore, it is possible that the present findings cannot be generalized. Due to the higher number of patients with high degrees of multimorbidity, sarcopenia prevalence may be overestimated because of unhealthy subject bias. Furthermore, as the present study was a cross-sectional study, it is not possible to infer a causal relationship with sarcopenia. A longitudinal study should be conducted to investigate the effects of sarcopenia prevention.

In conclusion, the present large cross-sectional study demonstrated that sarcopenia was more prevalent in outpatients than previously reported in community-dwelling older individuals and dietary variety status was associated with sarcopenia.

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Availability of data and materials

The data generated in the present study may be requested from the corresponding author.

Authors' contributions

DA and KMi confirm the authenticity of all the raw data. DA, KS, AN and KMi designed the study. DA and KMa interpreted data. DA wrote the manuscript. NY and YN performed statistical analysis. NSi, HS, NE, YI, MT, NSa, MI, MN, TM, SI and YM administered questionnaires. All authors have read and approved the final manuscript.

Ethics approval and consent to participate

The present study was conducted in accordance with the Declaration of Helsinki. The Juntendo Tokyo Koto Geriatric Medical Center Ethics Committee approved the study (approval no. G20-0011). Informed consent was obtained from each subject.

Patient consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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