Original

Association of Habitual Coffee Consumption with Probable Sarcopenia Assessed Using SARC-F in Community-Dwelling Japanese Older Adults: A Cross-Sectional Study

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ABSTRACT *Background and purpose*. To date, no study has examined the effect of coffee on sarcopenia while accounting for the intake of antioxidant-containing vegetables and fruits. We aimed to ascertain the association between habitual coffee consumption and probable sarcopenia among older Japanese adults using a screening tool for sarcopenia (strength, assistance with walking, rising from a chair, climbing stairs, and falls). *Methods*. This cross-sectional study was conducted in Mukawa, Hokkaido, Japan, between June and September 2022 and included 364 Japanese participants aged ≥65 years. Habitual coffee consumption was assessed using a validated self-administered food frequency questionnaire. Probable sarcopenia was determined using the "strength, assistance with walking, rising from a chair, climbing stairs, and falls" (SARC-F) scale. Multivariate logistic regression analysis was conducted to estimate the odds ratios (ORs) and confidence intervals (CIs) of probable sarcopenia risk across coffee consumption tertiles, with adjustments for sex, age, body mass index, living alone, habitual exercise, walking hours, current smoking status, current alcohol consumption, energy intake, and protein, fruit, and vegetable intake. *Results*. In our sample of 364 participants (154 males and 210 females), the probable sarcopenia rate was 9.3%. The multivariate-adjusted OR (95% CI) of ≥2 cups/day of coffee consumption compared with ≤3 cups/week for probable sarcopenia was 0.20 (0.06, 0.63) (*p* for trend=0.005). Increased habitual coffee consumption was inversely associated with probable sarcopenia in older Japanese adults. *Conclusions*. Coffee consumption of ≥2 cups/day may prevent sarcopenia. Further longitudinal studies are required to confirm these findings.

Keywords: coffee, cross-sectional study, nutritional epidemiology, older adult, sarcopenia

INTRODUCTION

Sarcopenia is a skeletal muscle disorder involving accelerated loss of muscle mass and function (1). Its prevalence rate ranges from 10% to 27% for the population aged ≥60 years (2). The number of people aged ≥65 years is expected to double from 703 million in 2019 to 1.5 billion in 2050, and the proportion is projected to increase from 9% to 16% (3). Sarcopenia is associated with increased poor health outcomes, including falls, functional decline, frailty, and mortality (1). Therefore, it is important to identify lifestyle factors that can reduce the risk of sarcopenia.

Sarcopenia is caused by various factors, including oxidative stress and inflammation (1,4); therefore, anti-inflammatory and antioxidant agents are considered to

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reduce sarcopenia. Coffee, which is the most frequently consumed beverage, contains phenolic compounds, such as chlorogenic acid and caffeic acid, which have strong antioxidant and anti-inflammatory effects as well as the potential to induce autophagy (5-8). Therefore, coffee consumption may prevent sarcopenia caused by inflammation and oxidative stress.

Four cross-sectional studies in humans have reported an association between coffee consumption and skeletal muscle mass, a key component of sarcopenia (9-12). Three studies showed that a significant positive association was found between higher coffee consumption and skeletal muscle mass loss (9-11). However, one study reported that light coffee consumption is protective against skeletal muscle mass loss. Specifically, the association between skeletal muscle mass and men who drink 1 cup of coffee per day remained significant, whereas no significant relationship was observed in men who drink ≥3 cups of coffee daily). A possible reason for the inconsistent results is that these studies (9-12) did not adjust for antioxidant-rich vegetables and fruits. Antioxidant-containing vegetables and fruits have been associated with a low risk of sarcopenia (13,14); thus, the influence of vegetables and fruits should be excluded when examining the association between coffee and skeletal muscle mass loss.

Therefore, the current study examined the association between habitual coffee consumption and probable sarcopenia among older Japanese adults, while accounting for vegetable and fruit intake.

MATERIALS AND METHODS

Study design and population

This cross-sectional study was conducted in Mukawa, east of Sapporo City, Hokkaido, Japan, between June and September 2022. The survey targeted individuals aged ≥20 years living in Mukawa. The town has a land area of 711.36 km^2 and a population of 7,579 individuals, with 41.2% of the population aged ≥65 years. In total, 1,051 residents were sent a postal invitation that included the study questionnaires. The completed questionnaires and written informed consent forms were collected by post. Residents underwent specific health checkups, medical checkups for older adults, and cancer screening. In total, 551 individuals were included in the study; based on the results of the checkups and screening, 500 were included via stratified random sampling, and 100 individuals were randomly selected from each age group from the basic resident register maintained until April 30, 2022. Age distribution in our sample was as follows: 20–29 years (n=100), 30–39 years (n=100), 40–49 years (n =146), 50–59 years (n=144), 60–69 years (n=220), 70–79 years (n=225), 80–89 years (n =108), and 90–99 years (n=8).

All participant information was anonymized and de-identified before the analysis. The study protocol, which complied with the tenets of the Declaration of Helsinki, was approved by the Ethics Committee of Rakuno Gakuen University (No. 22-1).

Dietary assessment

The validated self-administered Brief Diet History Questionnaire (BDHQ) (15-17) was used to evaluate the diet of the participants in the preceding month. The frequency of coffee consumption was classified into the following categories: almost none, <1 cup/month, 1 cup/week, 2–3 cups/week, 4–6 cups/week, 1 cup/day, 2–3 cups/day, or 4 cups/day.

A previous study assessed the validity of the BDHQ using dietary records. The correlation coefficients according to the BDHQ and those obtained from 16-day dietary records were 0.85 (males) and 0.87 (females) for coffee consumption, respectively, in a sample of 92 male participants aged 32–76 years and 92 female participants aged 31–69 years (16). In another sample of 36 male participants and 44 female participants aged 82–94 years, the correlation between a 3-day non-consecutive dietary record and the BDHQ was 0.67 for coffee consumption (17). Food and beverage data from the Standard Tables of Food Composition in Japan were used to calculate energy and protein intake. The types of coffee (type of beans or boiled/filtered/instant coffee) were not evaluated.

Probable sarcopenia assessment

Probable sarcopenia was assessed using the "strength, assistance with walking, rising from a chair, climbing stairs, and falls" (SARC-F) scale (17,18), which was initially developed in English and then translated into Japanese (19). The SARC-F includes questions in five domains: (1) strength, (2) walking assistance, (3) rising from a chair, (4) climbing stairs, and (5) falling. Each domain has single items, with scores ranging from 0 to 2 (Supplementary Table 1), and the total score ranged from 0 (best) to 10 (worst). A total score of 4 or higher indicates probable sarcopenia, and this study defined a score of 4 or higher as indicative of probable sarcopenia (18,19). In one study involving 959 hospitalized Japanese patients, the SARC-F showed a sensitivity of 41.7% and specificity of 68.5% (19).

Other variable assessments

Patient data, namely age, height, body weight, and alcohol consumption status, were collected through self-reported responses to the BDHQ questionnaire. The body mass index (BMI) was calculated as weight (in kg) divided by height squared (in m^2). Participants were classified into three BMI categories based on the 2022 guidelines for obesity management in Japan (20): <18.5, 18.5–24.9, and ≥25 kg/m^2. Alcohol consumption status was classified into eight categories ranging from almost none to daily. The participants also provided information on their living status (alone or with a companion), household income (four categories ranging from <2 to ≥6 million JPY), habitual exercise (defined as exercise for ≥30 min at least twice a week, for 1 year or more), walking hours (four categories ranging from <0.5 to ≥2 h/day), and smoking status (four categories: daily, sometimes, formerly, and never).

Statistical analyses

Participants' coffee consumption was divided into three categories: ≤3 cups/week, 4 cups/week–1 cup/day, and ≥2 cups/day. The data for both male and female participants were analyzed because the number of male participants was low. Participant characteristics were compared based on coffee consumption categories using linear regression analyses for continuous variables and the Mantel–Haenszel test for categorical variables.

The adjusted odds ratios (ORs) and confidence intervals (CIs) for probable sarcopenia were estimated according to coffee consumption using logistic regression analysis with the lowest category (<2 cups/week) as the reference. Model 1 was adjusted for sex (male or female), age (years, continuous), BMI (<18.5, 18.5–24.9, or ≥25 kg/m^2, or missing data), living alone (yes or no), habitual exercise (yes or no), walking hours (<0.5, 0.5–0.9,1.0–1.9, or 2 h/d), current smoking status (yes or no), current alcohol consumption (<1 cup/week or ≥1 cup/week), energy intake (kcal, continuous), and protein intake (g, continuous). Model 2 was adjusted for fruit and vegetable intake (g, continuous) because they have antioxidant properties that may modulate the effect of coffee consumption on probable sarcopenia. All statistical analyses were performed using SAS (ver. 9.4 Windows SAS Institute, Cary, NC, USA). Statistical significance was set at p <0.05.

RESULTS

A total of 623 participants (450 from specific health checkups, medical checkups for older adults, and cancer screening [40–49 years {n=33}; 50–59 years {n=39}; 60–69 years {n=98}; 70–79 years {n=191}; 80–89 years {n=86}; and 90–99 years {n=8}] and 173 from stratified random sampling [20–29 years {n=35}; 30–39 years {n=33}; 40–49 years {n=31}; 50–59 years {n=33}; and 60–69 years {n=41}]) completed the questionnaire survey (response rate, 79.6%; [specific health checkups, medical checkups for older adults, or cancer screening, 81.7%; and stratified random sampling, 34.6%]). Among them, 365 participants (aged ≥65 years) were eligible for inclusion. We excluded one participant with missing data in the SARC-F questionnaire (n=1). Thus, 364 participants were included in this study. An overview of the study enrolment procedure is shown in Figure 1. The proportion of women in the sample was 57.7%. The mean (standard deviation) age was 74.6 (6.1) (range, 65–94) years. Probable sarcopenia (sarcopenia score ≥ 4) was 9.3%.

Table 1 presents the participant characteristics according to coffee consumption. Participants with higher coffee consumption tended to have higher total energy, protein, vegetable, and fruit intakes.

Table 2 shows the crude and multivariate-adjusted ORs and 95% CIs for probable sarcopenia based on coffee consumption. The ORs of probable sarcopenia were significantly lower in the group with the highest coffee consumption (≥2 cups/day) than in the group with the lowest consumption (≤3 cups/week) after adjusting for sex, age, BMI, living alone, habitual exercise, walking hours, current smoking status, current alcohol consumption, energy intake, and protein intake (OR [95% CI]=0.20 [0.06, 0.64], p for trend=0.004) (Model 1 in Table 2). Similar results were obtained after adjusting for fruit and vegetable intake (OR [95% CI]=0.20 [0.06, 0.63]; p for trend=0.005) (Model 2 in Table 2).

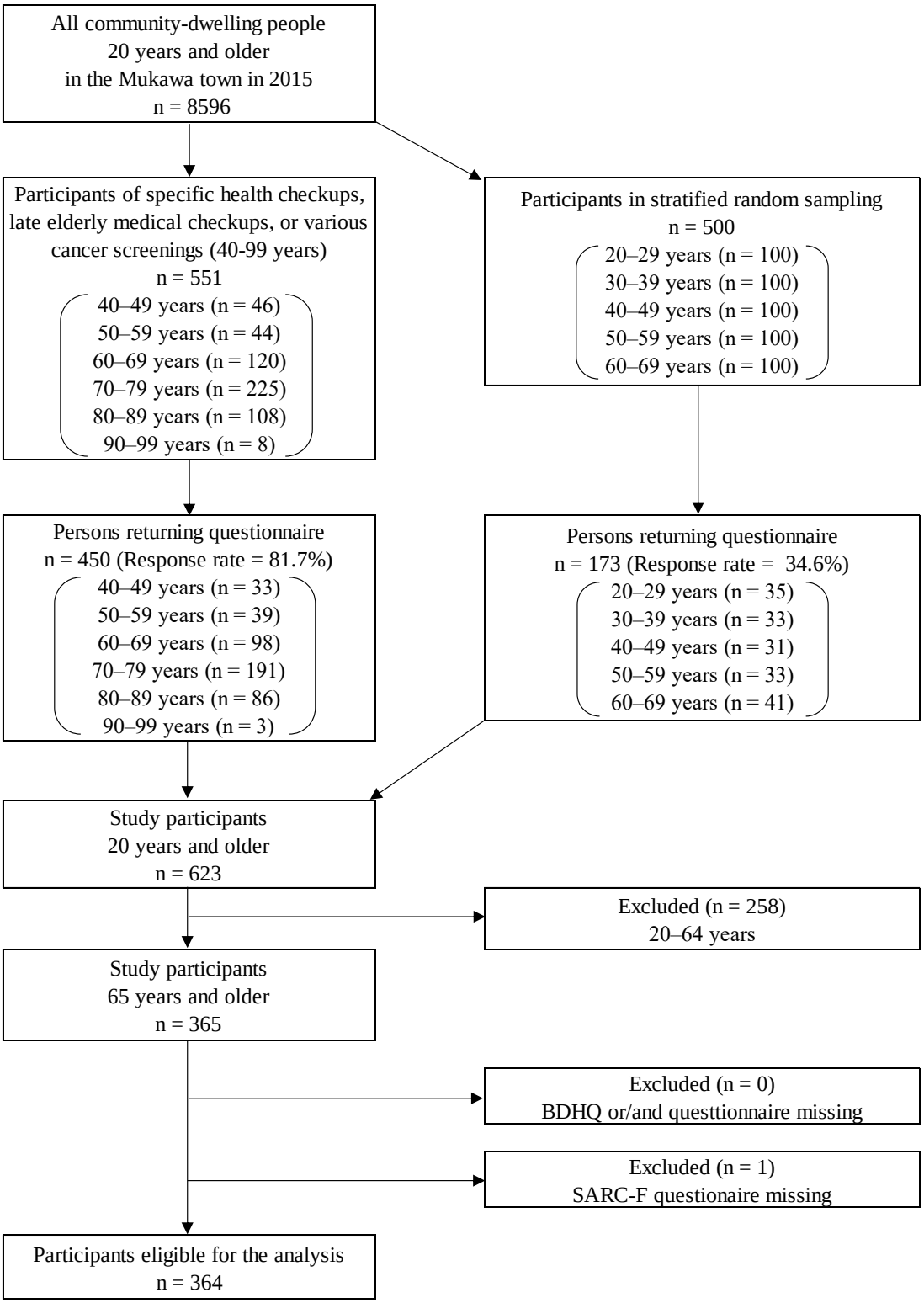

Figure 1. Flowchart depicting the participant enrolment process for this study

BDHQ, Brief Diet History Questionnaire; SARC-F, strength, assistance with walking, rising from a chair, climbing stairs, and falls

Table 1. Participant characteristics stratified by coffee consumption categories

	Coffee consumption						
	≤3 cups/week		4 cups/week–1 cup/day		≥2 cups/day		*p* for trend†
	Mean or n	SD or %	Mean or n	SD or %	Mean or n	SD or %	
All (n = 364)	(n=119)		(n=126)		(n=119)		
Age (years) †	76.5	6.5	73.6	6.2	73.7	5.1	**<0.001**
Females, n (%)	68	57.1	67	53.2	75	63.0	0.294
BMI, kg/m^2 †	23.9	4.2	23.1	3.7	23.6	3.7	0.624
BMI, kg/m^2, n (%)§							
<18.5	9	7.6	13	10.3	5	4.2	0.356
18.5–25	65	54.6	75	59.5	72	60.5	
≥25	44	37.0	38	30.2	42	35.3	
Missing							
Energy intake (kcal) †	1716	613	1682	540	1793	547	0.298
Protein (g) †	70.9	31.1	67.9	25.9	77.2	28.1	0.085
Vegetable (g) †	254.0	145.2	251.9	147.2	300.5	163.6	**0.019**
Fruit (g) †	94.5	82.9	98.6	92.1	104.0	82.4	0.393
Green tea consumption§							0.643
<1 cup/week	33	27.7	36	28.6	26	21.9	
1– 6 cup/week	24	20.2	34	27.0	32	26.9	
≥1 cup/day	62	52.1	56	44.4	61	51.3	
Living alone, n (%)§	27	22.7	27	21.4	21	17.7	0.606
Household income (<4 million JPY), n (%)§	94	79.0	99	78.6	94	79.0	
Missing	18	15.1	12	9.5	14	11.8	0.3572
Habitual exercise, n (%)§¶	69	58.0	74	58.7	60	50.4	0.357
Walking hours, h/day, n (%)§							0.548
<0.5	21	17.7	18	14.3	18	15.1	
0.5–0.9	43	36.1	37	29.4	36	30.3	
1–1.9	25	21.0	37	29.4	26	21.9	
≥2	30	25.2	34	27.0	39	32.8	
Educational level, n (%)§							0.153
Junior and senior high school graduates	105	88.2	108	85.7	94	79.0	
Junior college/vocational school graduate	7	5.9	13	10.3	13	10.9	
Universities/ postgraduate schools	6	5.0	5	4.0	12	10.1	
Missing	1	0.8	0	0.0	0	0.0	
Current smoker, n (%)§	4	3.4	18	14.3	11	9.2	**0.012**
Current alcohol consumption (≥1 cup/week), n (%)§	34	28.6	52	41.3	46	38.7	0.107
Missing data	1	0.8	0	0.0	0	0.0	
Probable sarcopenia, n (%)§	19	16.0	11	8.7	4	3.4	**0.004**

Bold *p*-values are statistically significant ($p<0.05$).. BMI, body mass index; SD, standard deviation. Values are expressed as means (SDs) for continuous variables and numbers (percentages) for categorical variables. *p*-values for linear trends across quartiles (assigned ordinal numbers 0–2) of coffee consumption are based on linear regression analysis for continuous variables and the Mantel test for categorical variables. ‡Continuous values are shown as means and standard deviations.
§Categorical values are shown as numbers and percentages. Habitual exercise was defined as ≥30 min/session and ≥2 times/week for at least 1 year. Probable sarcopenia was defined as scores ≥4 using SARC-F

Table 2. Crude and multivariate-adjusted odds ratios and 95% confidence intervals of probable sarcopenia according to coffee consumption

	Coffee consumption			*p* for trend[†]
	≤3 cups/week	4 cups/week-1 cup/day	≥2 cups/day	
All, n	119	126	119	
Probable sarcopenia, n (%)	19 (16.0)	11 (8.7)	4 (3.4)	
Crude model	1.00 (reference)	0.50 (0.23, 1.11)	**0.18 (0.06, 0.56)**	**0.001**
Model 1[‡]	1.00 (reference)	0.64 (0.27, 1.49)	**0.20 (0.06, 0.64)**	**0.006**
Model 2[§]	1.00 (reference)	0.63 (0.27, 1.47)	**0.20 (0.06, 0.63)**	**0.005**

Bold *p*-values are statistically significant ($p<0.05$).
[†]Based on the multiple logistic regression analysis with ordinal numbers 0–2 assigned to quartile-based categories of consumption.
[‡]Adjusted for sex (male or female), age (years, continuous), BMI (<18.5, 18.5–24.9, or ≥25 kg/m^2, or missing data), living alone (yes or no), habitual exercise (yes or no), walking hours (<0.5, 0.5–0.9,1.0–1.9, or 2 h/day), current smoking status (yes or no), current drinking (<1 cup/week or ≥1 cup/week), energy intake (kcal, continuous), and protein intake (g, continuous).
[§]Model 1+ fruit and vegetable intake (g, continuous).

DISCUSSION

This study demonstrated a negative correlation between coffee consumption and probable sarcopenia using the SARC-F scale in older Japanese adults. This association remained unchanged after adjusting for antioxidant-containing fruits and vegetables.

The results of the present study may be explained by phenolic compounds such as chlorogenic acid and caffeic acid, which are abundant in coffee. Chronic inflammation has been identified as a major factor that exacerbates the pathogenesis of sarcopenia (21). Aging is characterized by a redox imbalance between increased reactive oxygen species production and reduced antioxidant defense (22). In general, aging increases reactive oxygen species production in skeletal muscle (22). Thus, we considered that phenolic compounds such as chlorogenic acid and caffeic acid, which are abundant in coffee, exert anti-inflammatory and antioxidant effects and prevent sarcopenia caused by oxidative stress.

Several cross-sectional studies have reported an association between coffee consumption and skeletal muscle mass loss, a component of sarcopenia (9-12). However, these previous studies (9-12) did not adjust for antioxidant-containing fruit and vegetable intake. Hence, to the best of our knowledge, this is the first study to account for the antioxidants in fruits and vegetables, allowing us to analyze the effect of coffee on sarcopenia without this confounder factor.

The results of our study may aid in the development of preventative measures against sarcopenia and facilitate further research on methods of preventing sarcopenia. However, this study had a few limitations. First, because this study used a cross-sectional design, we could not determine whether the association between coffee consumption and probable sarcopenia was causal. Second, because the coffee consumption assessment was self-administered, the problem of potential misclassification arose. Third, the possibility of residual confounding factors could not be ruled out. For example, the consumption of foods other than coffee or tea and the intake of nutrients may have affected the results, although we adjusted for protein. Fourth, our sample size was small. Therefore, further large-scale studies are warranted. Fifth, we were unable to diagnose true sarcopenia because we used the SARC-F scale. However, we believe that the SARC-F scale accurately determined sarcopenia because, in a validation study, the SARC-F scale showed a sensitivity of 41.7% and a specificity of 68.5%[18] and the prevalence of probable sarcopenia in this study was

similar to that observed in the previous Japanese meta-analyses (prevalence of sarcopenia: 9.3% in our study; 9.9% in previous meta-analyses in Japan) (23). Sixth, we did not examine individual coffee types (type of beans or boiled/filtered/instant coffee). The amount of chlorogenic acid in coffee is known to vary by type (24,25). Therefore, the ranking of coffee consumption may not be consistent with the levels of chlorogenic acid and polyphenols, which are the factors that exert anti-inflammatory and antioxidative effects.

In conclusion, coffee consumption was inversely associated with probable sarcopenia. This association remained unchanged after adjusting for the intake of antioxidant-containing vegetables and fruits. Coffee consumption of ≥2 cups/day may prevent sarcopenia. Further longitudinal studies are required to confirm these findings.

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DATA AVAILABILITY STATEMENT

The data analyzed in this study are not publicly available because of privacy and ethical restrictions.

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Supplementary Table 1. The SARC-F Scale

Components	Questions	SARC-F Score
Strength	Did you experience any difficulty in lifting or carrying 10 pounds?	None = 0 Some = 1 Great difficulty or unable to lift = 2
Assistance in walking	Did you experience any difficulty in walking across a room?	None = 0 Some = 1 Great difficulty, use aids, or unable to walk = 2
Rising from a chair	Did you experience any difficulty in transferring from a chair or bed?	None = 0 Some = 1 Great difficulty or unable to transfer without help = 2
Climbing stairs	Did you experience any difficulty in climbing a flight of 10 steps?	None = 0 Some = 1 Great difficulty or unable to climb = 2
Falls	Did you experience any falls in the past year?	None = 0 1–3 falls = 1 4 or more falls = 2

SARC-F, screening tool for sarcopenia