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The effect of sarcopenia on cognitive function in community-dwelling older people

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Abstract

Background: The prevalence of sarcopenia has been suggested to have an association with cognitive decline. We aimed to investigate the association between the prevalence of sarcopenia and domain-specific cognitive function and to identify specific cognitive functions that are more susceptible to changes in skeletal muscle.

Method: Enrolled in this study were 249 elderly residents of Kaizuka City, Japan (mean age: 74.2 ± 6.8 years) who voluntarily participated in a measurement of their motor and cognitive functions. Sarcopenia was assessed according to the Asian Working Group for Sarcopenia 2019 algorithm, while cognitive function was assessed using the revised Japanese version of Addenbrooke's Cognitive Examination (ACE-R). Statistical analysis was performed by the Kruskal-Wallis test by ACE-R domain in three groups: healthy, sarcopenia and severe sarcopenia groups. The significance level was set at $< 5\%$.

Results: In the healthy group, the scores were 17.4 ± 1.1 in attention/orientation, 21.5 ± 4.5 in memory, 10.5 ± 2.2 in verbal fluency, 23.9 ± 3.0 in language, and 15.3 ± 1.4 points in visuospatial ability. In the sarcopenia group, the scores were comparable: 17.3 ± 1.0 in attention/orientation, 22.8 ± 1.0 memory, 22.8 ± 3.3 in verbal fluency, 10.3 ± 2.4 in language, and 24.6 ± 1.2 in visuospatial ability. In the severe sarcopenia group, the scores were also comparable: 15.3 ± 1.1 for attention/orientation, 18.0 ± 0 for memory, 21.5 ± 2.8 for verbal fluency, 10.5 ± 0.9 for language overall and 15.4 ± 0.7 points for visuospatial ability.

Conclusion: No association was identified between the prevalence of sarcopenia and cognitive decline in our study subjects.

Key words: older people living in the community, sarcopenia, cognitive function

INTRODUCTION

The total population of Japan today is 124.49 million, of which the elderly population, those aged ≥ 65 , accounts for 29.1% of the total population, a record high (Ministry of Internal Affairs and Communications, 2023). It is estimated that the elderly population will account for about 40% of the total population by 2060 (National Institute of Population and Social Security Research, 2023). In addition, the average life expectancy is said to be gradually increasing and the proportion of elderly people is increasing. However, the difference between the average life expectancy and *healthy* life expectancy is large, with the unhealthy period of restricted daily life being approximately 9 years for men and 13 years for women (Cabinet Office, 2023). Therefore, shortening the period in which individuals are in

need of nursing care and extending their *healthy* life expectancy is an urgent issue for Japan, a society with an especially long life expectancy. This may reduce medical and long-term care costs over the medium-to-long term and enable each individual to live as they wish despite their old age. By 2025, the nationwide medical costs have been estimated to be as high as 54 trillion yen and long-term care costs as much as 19.8 trillion yen (MHLW, 2023). Reducing the apparent gap between the average life expectancy and *healthy* life expectancy could lead to a reduction in medical and long-term care costs (Cabinet Office, 2023). Despite an increase in life expectancy of more than four years over the past 20 years, healthy life expectancy has only increased by 1.7 years for men and 1.1 years for women. The physical factors and environmental background that

are important for extending healthy life expectancy are unclear (Tsuji, 2023).

Senility is statistically the main cause of elderly people needing care (Ministry of Health, Labour and Welfare, Cabinet Office, 2023), and this includes what is known as frailty: vulnerability to stress due to age-related homeostasis and reduced physiological reserve due to age-related decline in various organ functions (Fried, 2001). Frailty is as a condition that can be hastened by intervention, yet it can lead to a range of poor outcomes. External factors include invasions from minor infections, accidents and undergoing surgery, and exposure to these external stresses is associated with higher complication rates, such as 1.2 times more delirium (Verloo, 2016) and almost twice as many infections (Zhu, 2022) in frail elderly people. There is also a higher risk of hospitalization (Fabricio-Wehbe, 2016), and an increased risk of re-hospitalization, leading to a higher risk of repeated hospital admissions and thus to a higher risk of needing care. Frail older adults are reported to be 1.2 times more likely to have impaired daily functioning (Ng, 2014), three times more likely to have a fall (Bartosch, 2020), and 8.6 times more likely to be institutionalized compared with healthy older people. They are also more likely to have health problems requiring hospitalization, and a higher rate of death. Frailty is an important consideration in estimating the life and functional prognosis of older people and in providing comprehensive healthcare for older people. Frailty is described as a state of need for care, in which independence is lost, and is distinguished from normal health in terms of vulnerability to the aforementioned external stresses (Kuzuya, 2015).

Frailty is a major cause of care needs, and it includes joint diseases, falls and fractures, and dementia. Many of these major causes of care needs are related to motor function, and treatment of sarcopenia in particular, with a focus on muscle function, is an especially urgent issue (Kuzuya, 2015). However, sarcopenia lacks subjective symptoms, meaning prompt appropriate diagnosis and intervention might not be possible. Various preventive measures have been reported but have not become established.

Sarcopenia is a progressive and systemic skeletal muscle disorder that, in addition to loss of muscle mass, is associated with muscle weakness or reduced physical function and can be associated with increase in poor outcomes such as falls, fractures, physical disability and death. Its prevalence in el-

derly Japanese community-dwelling individuals was reported to be 11.5% in men and 16.7% in women (Kitamura, 2021). This prevalence reportedly increases the risk of falls by approximately four times in men and two times in women (Tanimoto, 2014). Negative associations include the risk of osteoporosis being about three times higher (Yu, 2022), hospitalization being about 1.5 times higher (Bianchi, 2016), death being about two times higher (Landi, 2013) and diabetes being about two times higher (Koo, 2016). Sarcopenia has been suggested to be associated with cognitive function (Bai, 2021). The loss of skeletal muscle due to inactivity is likely to induce a decline in intellectual functioning, and an understanding of mechanisms is needed to improve cognitive function.

Sarcopenia has been linked with verbal fluency, which is part of cognitive function (Szejf, 2019), but the definition of sarcopenia adopted by the Foundation for the National Institutes of Health (FNIH) criteria differs from that used in Asia, so it is difficult to say whether the subjects are fully matched. The previous study also diagnosed cognitive function using the delayed word recall test, which assesses delayed word recall, the verbal fluency test, which assesses verbal fluency, and the trail making test version B, which assesses attention function. There is no assessment of cognitive domains such as disorientation, comprehension, writing and visuospatial cognition. The link between sarcopenia and cognitive function was based on older definitions of sarcopenia (Xiaolei, 2020).

Identification of cognitive functional domains associated with sarcopenia will enable the identification of those specifically associated with muscle atrophy and muscle weakness. This could allow analysis of the interrelationships between the mechanisms leading to them. Here, we therefore investigate the association between the prevalence of sarcopenia and domain-specific cognitive function, aiming to identify specific cognitive functions that are more likely to be affected by skeletomuscular changes.

METHODS

Subjects

The subjects of this study were 249 elderly residents of Kaizuka City, Japan (67 men and 182 women) with an average age of 74.2 ± 6.8 years, who self-applied by postcard after seeing an item in a local newsletter on measurement of motor and

cognitive functions. Recruitment was via responses to leaflets and postcards posted in the city twice in July 2022. Measurements were then taken for a total of seven days at three locations in the city between August and September 2022. Excluded from consideration in this study were participants with pacemakers, those with visual impairment that might affect their ability to perform the necessary tasks, and those in whom it was not possible to assess all cognitive functions (Figure 1).

Ethical considerations regarding this study are based on the Declaration of Helsinki and with approval by the Osaka Kawasaki Rehabilitation University Ethics Review Committee (approval number OK-RU-RA0027).

Assessment of sarcopenia

Sarcopenia was assessed according to the algorithm of the AWGS2019 study objectives (Chen, 2019). Grip strength was used to assess muscle strength, bioimpedance analysis was used for skeletal muscle mass, and gait speed was used for physical function. The patients were classified into three groups according to the algorithm. The sarcopenia group was defined as low skeletal muscle mass + low muscle strength, or low skeletal muscle mass + low body function. The severe sarcopenia group was defined as low skeletal muscle mass + low muscle strength + low body function.

Grip strength values, measured using a digital grip strength meter (Takei Hand Grip Dynamometer, Takei Scientific Instruments Co., Ltd., Niigata, Japan) were used to assess muscle strength. The measurements were performed in the standing position and, as a rule, with the participant's dominant hand. The cut-off values were <28.0 kg for men and <18.0 kg for women, in accordance with the AWGS 2019 algorithm (Chen, 2019).

Skeletal muscle mass was assessed using bioimpedance analysis. Body weight, body fat percentage and skeletal muscle mass by region were measured using a body composition measuring device (Inbody 270, InBody Co., Ltd., Seoul, South Korea), and the total muscle mass of the limbs was divided by the square of the height (m) to calculate the skeletal muscle mass index. The cut-off values were <7.0 kg/m² for men and <5.7 kg/m² for women.

Walking speed was used as an assessment of physical function. It was measured using a stopwatch at the subject's usual comfortable walking speed. The measurement section was a 2.4 m walking path with a of 2 m sections before and after. The cut-off value was 1.0 m/sec. Five measurements were taken and the average walking speed of the five measurements was calculated and used as the walking speed.

Cognitive function assessment

Addenbrooke's Cognitive Examination Revised (ACE-R) was used for cognitive function.

ACE-R is a cognitive function test to detect dementia in its early stages and is reportedly useful for accurately detecting the early stages of dementia in healthy older people (Dos Santos Kawata, 2012). ACE-R is divided into five main items, listed here with the score distribution: attention/orientation (18 points), memory (26 points), verbal fluency (14 points), language (26 points) and visuospatial ability (16 points), for a total score of 100 points. The test also includes the Mini-Mental State Examination (MMSE) with questions to assess each cognitive domain in more detail (Dos Santos Kawata, 2012). Measurements were taken in a space isolated from other measurement areas, with one subject answering questions from one examiner and one subject writing the answers.

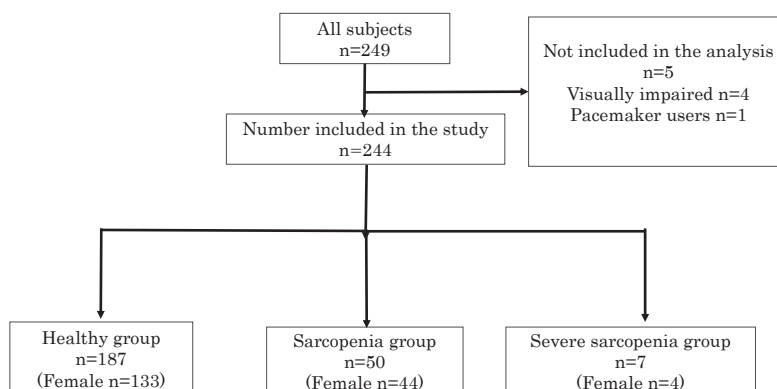


Figure 1. Flowchart of participants

Statistical analysis

Statistical analyses were firstly conducted to examine normality, then Shapiro-Wilk tests were performed on gender, age, height, weight, skeletal muscle mass index, grip strength walking speed and domain-specific cognitive functions: attention/orientation total, memory total, verbal fluency total, language total and visuospatial ability total. Equal variances were also performed with the Levene test.

The cognitive functional domains of ACE-R in the healthy, sarcopenia and severe sarcopenia groups were compared using the Kruskal-Wallis test. As a secondary analysis, the Kruskal-Wallis test was used to compare sarcopenia severity and cognitive domains across the three groups of elderly persons aged ≥ 75 years. It was also used to compare sarcopenia severity and domain-specific cognitive domains in the three groups, with male and female subjects separated. All statistical procedures were analyzed using SPSS version 28 (IBM). The signifi-

cance level was set at $< 5\%$.

RESULTS

The analysis was performed on 244 subjects, excluding five who met the exclusion criteria: the respective proportions of the three groups were 187 in the healthy group (76.6%), 50 in the sarcopenia group (20.5%) and seven in the severe sarcopenia group (2.9%).

The median values for each item are shown in Tables 1 and 2. There was no significance and no trends between the prevalence of sarcopenia and domain-specific cognitive function domains.

Sub-analysis of late-elderly participants

A sub-analysis was performed on 117 late-elderly individuals (age ≥ 75 years). The median scores for each item were as follows: in the normal group, it was 17.4 ± 1.1 points for attention/orientation, 20.9 ± 3.7

Table 1. Basic attributes classifying subjects into three groups

	Healthy group n=186	Sarcopenia group n=50	Severe sarcopenia group n=7	p-value
Gender (Female (%))	133(71.1)	44(88.0)	4 (57.1)	0.31
Age (years)	73.3 ± 6.9	76.9 ± 5.9	78.4 ± 4.7	< 0.05
Height (cm)	156.8 ± 8.3	150.3 ± 7.3	151.2 ± 6.6	< 0.05
Weight (kg)	55.5 ± 9.9	46.6 ± 7.0	48.3 ± 5.8	< 0.05
SMI (kg/m ²)	6.1 ± 0.9	5.1 ± 0.6	5.2 ± 0.4	< 0.05
Grip strength (kg)	25.1 ± 7.0	16.7 ± 4.6	15.4 ± 0.9	< 0.05
Walking speed (m/sec)	1.3 ± 0.1	1.2 ± 0.2	0.6 ± 0.3	< 0.05

Values are median \pm standard deviation or n KruskalWallistest or χ^2 test
SMI : Skeletal Muscle mass Index

Table 2. Cognitive function sub-items of the subjects

Item	Healthy group n=187	Sarcopenia group n=50	Severe sarcopenia group n=7	p-value
Attention and disorientation overall (points)	17.4 ± 1.1	17.3 ± 1.0	18.0 ± 0.0	0.36
Memory Overall (points)	21.5 ± 4.5	22.8 ± 3.3	21.5 ± 2.8	0.15
Fluency Overall (points)	10.5 ± 2.2	10.3 ± 2.4	10.5 ± 0.9	0.12
Language Comprehensive (points)	23.9 ± 3.0	24.6 ± 1.2	24.7 ± 1.1	0.17
Visuospatial synthesis (points)	15.3 ± 1.4	15.3 ± 1.1	15.4 ± 0.7	0.90
ACER total (points)	91.0 ± 8.4	91.0 ± 6.2	90.0 ± 4.2	0.28

KruskalWallistest Values are median \pm standard deviation
ACER: Addenbrooke's Cognitive Examination Revised

for memory, 10.4 ± 2.2 for verbal fluency, 24.0 ± 2.2 for language, and 15.5 ± 0.8 for visuospatial ability. In the sarcopenia group, the values were comparable: 17.2 ± 1.2 points for attention/orientation, 22.5 ± 3.7 for memory, and 10.2 ± 2.8 for verbal fluency. 10.2 ± 2.2 for verbal fluency, 24.7 ± 1.2 for language, and 15.2 ± 1.1 for visuospatial ability. In the severe sarco-

penia group, the values were also comparable: 18.0 ± 0 for attention/orientation, 21.2 ± 3.2 for memory, 10.6 ± 1.1 for verbal fluency, 25.0 ± 1.0 for language, and 15.4 ± 0.8 for visuospatial ability. There were no significant differences or trends between the prevalence of sarcopenia and domain-specific cognitive domains (Figure 2) (Table 3, 4).

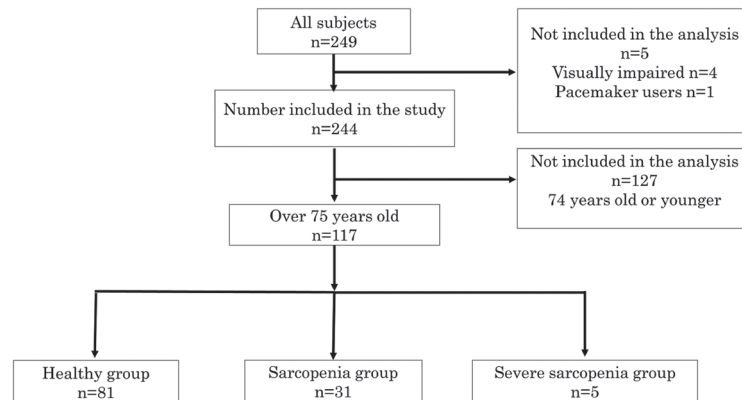


Figure 2. Flow Chart for the 75+ Age Group

Table 3. Basic attributes of three groups of 75 years and older

	Healthy group n=81	Sarcopenia group n=31	Severe sarcopenia group n=5	p-value
Gender (Female (%))	53(65.4)	27(87.1)	3(60.0)	0.67
Age (years)	79.0 ± 3.5	81.0 ± 3.1	83.0 ± 4.0	0.23
Height (cm)	154.6 ± 9.0	148.6 ± 6.3	149.1 ± 7.2	<0.05
Weight (kg)	53.4 ± 9.9	47.4 ± 5.8	50.0 ± 6.1	<0.05
SMI(kg/m ²)	5.9 ± 1.0	5.2 ± 0.5	5.2 ± 0.5	<0.05
Grip strength (kg)	22.0 ± 6.9	15.7 ± 4.8	15.6 ± 1.0	<0.05
Walking speed (1 m/sec)	1.2 ± 0.1	1.1 ± 0.2	0.7 ± 0.3	<0.05

Kruskal-Wallis test Values are median \pm standard deviation

SMI : Skeletal Muscle mass Index

Table 4. Cognitive function subcategories for age 75 and older

Item	Healthy group n=81	Sarcopenia group n=31	Severe sarcopenia group n=5	p-value
Attention and disorientation overall (points)	17.4 ± 1.1	17.2 ± 1.2	18.0 ± 0.0	0.39
Memory Overall (points)	20.9 ± 3.7	22.5 ± 3.7	21.2 ± 3.2	0.26
Fluency Overall (points)	10.4 ± 2.4	10.2 ± 2.2	10.6 ± 1.1	0.31
Language Comprehensive (points)	24.0 ± 2.2	24.7 ± 1.2	25.0 ± 1.0	0.60
Visuospatial synthesis (points)	15.5 ± 0.8	15.2 ± 1.1	15.4 ± 0.8	0.34
ACER total (points)	88.3 ± 9.2	90.0 ± 6.7	90.0 ± 5.1	0.38

Kruskal-Wallis test Values are median \pm standard deviation

ACER: Addenbrooke's Cognitive Examination Revised

Sub-analysis comparison of men in the three groups

The sub-analysis was performed on the 63 male participants. The median scores for each item were as follows: in the healthy group, it was 17.4 ± 1.0 for attention/orientation, 21.4 ± 4.7 for memory, 10.2 ± 2.2 for verbal fluency, 23.7 ± 3.4 for language, and 15.1 ± 2.2 for visuospatial ability. The sarcopenia group was again comparable with the healthy group: 17.3 ± 1.2 for attention/orientation, 20.8 ± 4.3 for memory, and 10.1 ± 0.2 for verbal fluency, 23.8 ± 1.1 for language and 15.6 ± 0.5 for visuospatial ability. Also, the severe sarcopenia group was comparable: 18.0 ± 0 for attention/orientation, 22.6 ± 2.3 for memory, 10.6 ± 1.5 for verbal fluency, and 24.6 ± 1.5 for language and 15.6 ± 0.5 for visuospatial ability. Again, there were no significant differences or trends between the prevalence of sarcopenia and domain-specific cognitive function domains (Tables 5, 6).

Sub-analysis comparison of women in the three groups

A sub-analysis was performed on the 181 female participants. The median scores for each item in the healthy group were: 17.4 ± 1.1 for attention/orientation, 21.6 ± 4.4 for memory, 10.6 ± 2.2 for verbal fluency, 24.2 ± 2.0 for language, and 15.5 ± 0.9 for visuospatial ability. They were similar in the sarcopenia group: 17.3 ± 1.0 for attention/orientation, 23.1 ± 3.1 for memory, and 10.3 ± 2.9 for verbal fluency, 24.7 ± 1.2 for language and 15.2 ± 1.1 for visuospatial ability. Likewise, there was similarity in the severe sarcopenia group: 18.0 ± 0 for attention/orientation, 20.7 ± 3.3 for memory, 10.5 ± 0.5 for verbal fluency, 24.7 ± 0.9 for language, and 15.2 ± 0.9 for visuospatial ability. Once again, there were no significant differences or trends between the prevalence of sarcopenia and domain-specific cognitive function domains (Tables 7, 8).

Table 5. Basic attributes classifying men into three groups

	Healthy group n=54	Sarcopenia group n=6	Severe sarcopenia group n=3	p-value
Age (years)	75.0 ± 6.9	78.0 ± 6.6	75.0 ± 0.4	0.67
Height (cm)	165.4 ± 6.5	161.5 ± 5.8	158.1 ± 6.4	0.32
Weight (kg)	65.2 ± 8.2	55.9 ± 7.0	45.3 ± 6.5	<0.05
SMI(kg/m ²)	7.5 ± 0.6	6.4 ± 0.3	5.6 ± 0.3	<0.05
Grip strength (kg)	33.4 ± 6.0	26.3 ± 3.3	15.6 ± 1.1	<0.05
Walking speed (1 m/sec)	1.2 ± 0.1	1.2 ± 0.3	0.7 ± 0.1	<0.05

Kruskal-Wallis test Values are median \pm standard deviation

SMI : Skeletal Muscle mass Index

Table 6. Cognitive function subitems for males only

Item	Healthy group n=54	Sarcopenia group n=6	Severe sarcopenia group n=3	p-value
Attention and disorientation overall (points)	17.4 ± 1.0	17.3 ± 1.2	18.0 ± 0.0	0.66
Memory Overall (points)	21.4 ± 4.7	20.8 ± 4.3	22.6 ± 2.3	0.76
Fluency Overall (points)	10.2 ± 2.2	10.1 ± 0.7	10.6 ± 1.5	0.11
Language Comprehensive (points)	23.7 ± 3.4	23.8 ± 1.1	24.6 ± 1.5	0.74
Visuospatial synthesis (points)	15.1 ± 2.2	15.6 ± 0.5	15.6 ± 0.5	0.78
ACER total (points)	87.9 ± 9.4	87.8 ± 6.5	91.6 ± 3.0	0.64

Kruskal-Wallis test Values are median \pm standard deviation

ACER: Addenbrooke's Cognitive Examination Revised

Table 7. Basic attributes classifying women into three groups

	Healthy group n=133	Sarcopenia group n=44	Severe sarcopenia group n=4	p-value
Age (years)	73.0 ± 6.9	78.0 ± 5.9	80.0 ± 5.1	<0.05
Height (cm)	153.3 ± 5.9	147.9 ± 6.1	146.8 ± 3.6	<0.05
Weight (kg)	50.4 ± 7.4	46.0 ± 5.7	50.5 ± 6.1	<0.05
SMI(kg/m ²)	5.6 ± 0.5	5.1 ± 0.4	5.2 ± 0.4	<0.05
Grip strength (kg)	21.2 ± 3.4	15.9 ± 2.9	15.3 ± 0.8	<0.05
Walking speed (1 m/sec)	1.3 ± 0.1	1.2 ± 0.2	0.7 ± 0.4	<0.05

Kruskal-Wallis test Values are median ± standard deviation

SMI : Skeletal Muscle mass Index

Table 8. Cognitive function subitems for women only

Item	Healthy group n=133	Sarcopenia group n=44	Severe sarcopenia group n=4	p-value
Attention and disorientation overall (points)	17.4 ± 1.1	17.3 ± 1.0	18.0 ± 0.0	0.56
Memory Overall (points)	21.6 ± 4.4	23.1 ± 3.1	20.7 ± 3.3	0.40
Fluency Overall (points)	10.6 ± 2.2	10.3 ± 2.6	10.5 ± 0.5	0.10
Language Comprehension (points)	24.2 ± 2.0	24.7 ± 1.2	24.7 ± 0.9	0.15
Visuospatial synthesis (points)	15.5 ± 0.9	15.2 ± 1.1	15.2 ± 0.9	0.32
ACER total (points)	89.4 ± 8.0	90.8 ± 6.2	89.2 ± 5.1	0.48

Kruskal-Wallis test Values are median ± standard deviation

ACER: Addenbrooke's Cognitive Examination Revised

DISCUSSION

We investigated the association between the prevalence of sarcopenia and domain-specific cognitive function in community-dwelling older people. The prevalence of sarcopenia was 20.5% and the prevalence of severe sarcopenia was 2.9%. No significant differences or trends were found between the prevalence of sarcopenia and domain-specific cognitive function.

In a previous longitudinal study that investigated the association between sarcopenia and mild cognitive impairment in community-dwelling older people aged ≥50 years in three different years, the prevalence of sarcopenia was 10.5%, 20.7% and 23.3%, respectively, and there was a longitudinal association between sarcopenia and mild cognitive impairment (Salinas-Rodriguez, 2021). The prevalence of sarcopenia was thought to be similar to that in our current study.

However, these results differ from those of another previous study (Szlejf, 2019), which reported a negative association between sarcopenia and verbal

fluency. Possible reasons for this include different diagnostic criteria for sarcopenia and different assessment of cognitive function. The diagnostic criteria for sarcopenia were assessed by the FNIH, while only language fluency, delayed word recall, and attention function were assessed to determine cognitive function. The FNIH assesses grip strength and limb lean body mass, whereas this study assesses sarcopenia using grip strength, skeletal muscle mass and walking speed, which could explain why our results differ from their study showing association between sarcopenia and verbal fluency.

A previous study of women who were able to walk independently reported that sarcopenia was associated with cognitive impairment at an advanced stage and that changes in body composition may not occur in the pre-cognitive stage of cognitive impairment (Abellan, 2013). Mild and moderate cognitive impairment is reportedly not associated with loss of lean mass (Wirth, 2011). Another study showed association between sarcopenia and cognitive function and behavioral/psychological symptoms in people requir-

ing support and care who used day services. There was no association with cognitive function, but an association was shown with behavioral psychological symptoms (Kawata, 2018).

We found no association between sarcopenia and domain-specific cognitive function, as 67.6% of our subjects had normal cognitive function and there were no significant differences between the three groups. Elsewhere, an association was shown with mild cognitive impairment in a study investigating the association between sarcopenia and cognitive function in East Asian subjects aged ≥ 80 years, excluding those with severe impairment in activities of daily living (Bai, 2021). Meanwhile, good social participation activities were associated with better cognitive function in a study of community-dwelling older people without dementia (Krueger, 2009). In a systematic review investigating the association between social activity, social networks, social support and social environment effects, cognitive function was affected in healthy older people (Kelly, 2017). Considering these findings, it is possible that the subjects in the current study had relatively high levels of social participation because they voluntarily applied for motor and cognitive function measurement sessions on their own. Participants in health checks have been shown to be particularly interested in their health (Dryden, 2012). The population in the current study contained a relatively high number of participants who had maintained independent activities of daily living compared with previous studies, and this might have skewed our results.

In a previous study of community-dwelling older people with independence in activities of daily living, 7.9% of men and 7.3% of women had severe sarcopenia (Guillamon-Escudero, 2020), and in another study, the prevalence of severe sarcopenia in health check-up participants was 5.8% (Kitamura, 2021). Another that investigated community-dwelling older people using the AWGS2019 algorithm for sarcopenia reported the prevalence of severe sarcopenia as 9.4% (Sri-On, 2022). The prevalence of severe sarcopenia in the current study was 2.9%, and thus much lower than that in previous studies.

A higher number of our subjects were independent in their activities of daily living compared with those in previous studies and they had a high level of physical and social participation activities, sufficient at least for them to voluntarily apply for motor function and cognitive function measurement sessions. A meta-analysis that consolidated the relationship between physical activity and sarcopenia (Steffl, 2017) report-

ed that the higher the physical activity level, the lower the risk of sarcopenia prevalence, which may explain the prevalence of severe sarcopenia in the present study being lower than that in previous studies.

Low nutrition and sarcopenia are reportedly related (Uemura, 2017; Beaudart, 2019) and the prevalence of sarcopenia tends to be higher in subjects who are comparatively uninterested in their health and do not undergo health checks (Fujita, 2004). Insufficient physical activity decreases the frequency of going out and makes potential participants more confined, leading to poor social participation (Fujita, 2004). Sarcopenia is reportedly significantly associated with low social participation (Sato, 2021). Another study (Buchman, 2009), which investigated the tracking of changes in social participation and motor function, excluding those with dementia, strokes and Parkinson's disease, reported that reduced social participation suggested a decline in motor function. Another investigated the relationship between social participation activities and physical fitness in people living in communities but not certified for long-term care in Japan (Haeuchi, 2016). Older people with higher participation in social activities performed better in the lower limb movement skills of five chair standing movements, 5 m walking speed and open-eyed one-leg standing. This suggests a relationship between social participation activities and physical fitness. Furthermore, a cross-sectional study investigating the association between physical activity and sarcopenia reported that sedentary subjects were associated with sarcopenia and sarcopenic obesity (Aggio, 2016). Inadequate physical activity has been reported to be a predictor of reduced walking speed, muscle strength and the ability to stand and sit in a chair (Laddu, 2020).

In summary, various studies have shown that inadequate physical activity, reduced frequency of going out, increased seclusion and poor social participation may lead to reduced muscle mass, reduced walking speed, and sarcopenia (Tuttle, 2020). Inflammation caused by ageing, as well as the reduction in the speed of walking and loss of independence in activities of daily living as they become difficult, decreased social participation, decreased frequency of outings, could lead to people becoming more confined and reducing their physical activity. A high prevalence of severe sarcopenia can be inferred in subjects with inadequate physical activity and lack of interest in health and independence in the activities of daily living, who were not included in the present study.

There are a number of limitations to this study that should be taken into account. The subjects were all elderly people living in a single municipality and they were comparatively small in number. Secondly, most of the subjects in this study had high cognitive function and there was no association between the prevalence of sarcopenia and domain-specific cognitive function. However, in subjects with low cognitive function, an association may be found between the prevalence of sarcopenia and domain-specific cognitive function. In addition, the prevalence of sarcopenia and severe sarcopenia may be estimated to be low because many of the subjects are independent in their activities of daily living and are particularly highly interested in their health, as demonstrated by actively volunteering for the assessment. It is necessary to investigate the relationship between the prevalence of sarcopenia and cognitive function by domain by using a survey table to select those with poor social participation and by changing the target group to include those in need of support and those in need of care who are not independent in activities of daily living.

In conclusion, we found no association between the prevalence of sarcopenia and cognitive decline in our study subjects. Further studies will focus upon more vulnerable groups, particularly those with comparatively low social participation and without independence in activities of daily living. The Japanese version of this thesis content is submitted as a master's thesis at Osaka Kawasaki Rehabilitation University.

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