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Original Article

# Association between Depressive Symptoms and Sarcopenia in Older Individuals Requiring Long-Term Care

Ryo Sato [a,b], Yohei Sawaya [b,c], Masahiro Ishizaka [c], Takahiro Shiba [b], Tamaki Hirose [b,c], Tomohiko Urano [b,d] *

[a] *Graduate School of Health and Welfare Sciences, International University of Health and Welfare, Tokyo, Japan,* [b] *Department of Day Rehabilitation, Care Facility for the Elderly "Maronie-en", Nasushiobara, Japan,* [c] *Department of Physical Therapy, School of Health Sciences, International University of Health and Welfare, Otawara, Japan,* [d] *Department of Geriatric Medicine, School of Medicine, International University of Health and Welfare, Narita, Japan*

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SUMMARY

*Background:* The association between depression and sarcopenia is unclear. Therefore, this study aimed to investigate the relationship between depressive symptoms and sarcopenia in older individuals requiring long-term care.
*Methods:* This cross-sectional study analyzed the baseline data of 121 older individuals who needed support and long-term care in their daily lives and received daycare for adults between March 2019 and March 2021. We defined sarcopenia using diagnostic algorithms recommended by the Asian Working Group of Sarcopenia 2019 and classified all participants into three categories — robust, sarcopenia, and severe sarcopenia. Skeletal muscle mass was measured using bioelectrical impedance, and depressive symptoms were assessed using the Geriatric Depression Scale-15.
*Results:* Of the 121 participants, 57.9% were classified as having depressive symptoms. Participants with depressive symptoms had significantly more illnesses, including cerebrovascular disease, malnutrition, and sarcopenia, than those without depressive symptoms. Multiple regression analysis showed that the depression was associated with skeletal muscle mass but not with grip strength or walking speed.
*Conclusion:* Depressive symptoms are associated with cerebrovascular disease, malnutrition, and sarcopenia. In terms of the diagnostic factors for sarcopenia, depressive symptoms were associated with skeletal muscle mass but not with grip strength or walking speed.



## 1. Introduction

Depression is a common psychological disorder that affects approximately 322 million people worldwide,[1] and in Japan, approximately 28.7% of older adults population is reported to experience depressive symptoms.[2] Depressive symptoms in older individuals are associated with a variety of chronic diseases, including cerebrovascular disease, and can worsen many disease outcomes, leading to earlier mortality and increased medical and nursing care costs.[3,4]

Sarcopenia is an age-related loss of muscle strength and skeletal muscle mass.[5] Sarcopenia negatively affects life expectancy due to complications from various diseases, and can further increase the level of care needed.[6] A systematic review reported that depression in older individuals is independently associated with sarcopenia.[7] However, the diagnostic criteria for sarcopenia in Asians were revised in 2019 and indicated no association with depression.[2] Thus, the association between the latest diagnostic criteria for sarcopenia and depression is not clear. Furthermore, these diagnostic criteria are based on three factors — grip strength, walking speed, and skeletal muscle mass. Hayashi et al. reported that depressive symptoms in healthy older individuals were not associated with skeletal muscle mass.[8] Since most previous studies analyzed healthy older adults populations, further studies evaluating different older adults populations are needed to understand the association between depressive symptoms and sarcopenia. Older individuals requiring long-term care more focused assessments and interventions than healthy older individuals. However, to the best of our knowledge, no studies have examined the association between sarcopenia and depressive symptoms in older individuals requiring long-term care. Since sarcopenia and depressive symptoms are more common in older individuals requiring long-term care than in healthy older individuals, depressive symptoms in older individuals requiring long-term care may be related to sarcopenia. Based on the current diagnostic criteria for sarcopenia, clarifying the association between sarcopenia and depressive symptoms will be useful for analyzing the current status of the aging society and preventing long-term care.

Therefore, this study aimed to assess sarcopenia in older patients requiring long-term care using the Asian Working Group for Sarcopenia 2019 (AWGS 2019) diagnostic criteria (1) to examine the association between sarcopenia and depressive symptoms and (2) to identify diagnostic factors for sarcopenia that are associated with depressive symptoms.

* Corresponding author. Department of Geriatric Medicine, School of Medicine, International University of Health and Welfare, Kozunomori 4-3, Narita, Chiba 286-8686, Japan.
*E-mail address:* turanotky@gmail.com (T. Urano)

## 2. Material and methods

### 2.1. Data and participants

This cross-sectional study evaluated 121 outpatients who received daycare for adults between March 2019 and March 2021, and were determined to require support levels 1 and 2, as well as care level 1 under Japan's long-term care insurance system.[9]

The exclusion criteria were as follows: (1) those diagnosed with aphasia or dementia and (2) those aged < 65 years. In conducting the program, all participants were fully informed of the study purpose and measurement methods, and consent was obtained for participation. This study was conducted in accordance with the Declaration of Helsinki, and informed consent was obtained from all participants or their families. The protocol was approved by the ethics committee (approval number: 17-Io-189-7).

### 2.2. Definition of sarcopenia

Sarcopenia was diagnosed according to the diagnostic criteria of the AWGS 2019.[10] Grip strength was measured using a grip strength meter (model TKK5401 Grip-D; Takei Scientific Instruments Co., Ltd., Niigata, Japan) twice each on the left and right sides with the participant sitting in a chair in an upright position, and the maximum value was used as the representative value. The walking speed was calculated from the typical walking speed between the 3 m and 8 m marks (5 m) on an 11 m walking path. A walking aid was used to ensure normal walking. The index of skeletal muscle mass was measured using the bioelectrical impedance method using a body composition analyzer (InBody520, Biospace Co., Korea), and the Baumgartner et al. Muscle index (skeletal muscle mass index [SMI]) was calculated.[11] The limbs were measured with the participant in a standing position, according to the manufacturer's instructions.

Sarcopenia was diagnosed according to the following AWGS 2019 diagnostic criteria: low muscle strength (grip strength: male < 28 kg, female < 18 kg), low physical function (walking speed < 1 m/s), and low skeletal muscle mass (SMI: male < 7.0 kg/$m^2$, female < 5.7 kg/$m^2$). Low muscle strength and low physical function and low skeletal muscle mass were indicative of severe sarcopenia. In this study, the patients were divided into three groups: robust, sarcopenia, and severe sarcopenia.

### 2.3. Outcome variables

The Geriatric Depression Scale 15 (GDS-15) was used to evaluate depression.[12] The printed question items were read aloud by the examiner, and the participants were instructed to answer "yes" or "no." GDS-15 scores of < 5 indicated no depressive symptoms, while a score of ≥ 5 was considered to indicate depressive tendencies. Participants were classified into two groups based on the GDS-15 score.

### 2.4. Other covariates

Data regarding age, sex, and existing diseases (cerebrovascular, cardiopulmonary, malignant tumor, diabetes, orthopedic, and intractable neurological diseases) were obtained from the medical records of the institution. Existing disease was diagnosed by doctors. Activities of daily living (ADL) were assessed using the Barthel index. Nutritional assessment was performed using the Mini Nutritional Assessment Short-Form (MNA-SF),[13] and participants were classified into three groups accordingly: malnourished (score of ≤ 7), at risk of malnutrition (score of 8–11), and normal nutritional status (score of 12–14). MNA-SF consists of the following evaluation items: A: "Has food intake declined over the past 3 months due to loss of appetite, digestive problems, chewing or swallowing difficulties?"; B: "Weight loss during the last 3 months"; C: "Mobility"; D: "Has suffered psychological stress or acute disease in the past 3 months?"; E: "Neuropsychological problems"; and F: "Calf circumference (CC) in cm." These measurements were assessed by a physical therapist working in the adult daycare center.

### 2.5. Statistical analyses

The $\chi^2$ test, Fisher's exact test, unpaired t-test, and Mann-Whitney U test were used to determine the differences between the non-depressed and depressed groups. To investigate the independent association between depression and sarcopenia, a binomial logistic regression analysis was performed to calculate the odds ratios (ORs) and 95% confidence intervals (CIs). Next, multiple regression analysis was conducted with each diagnostic item of sarcopenia as the dependent variable and depressive symptoms (depression: 1, non-depression: 0) as the independent variable to clarify the association between diagnostic items of sarcopenia and depression. All statistical analyses were performed using the Statistical Package for the Social Sciences Statistics version 25 (International Business Machines Corp., Armonk, NY, USA). Statistical significance was set at $p < 0.05$ in all analyses. Power analysis was performed using G*Power version 3.1.

## 3. Results

Figure 1 shows the flowchart of study participants. A total of 121 participants were included, of whom 51 and 70 were assigned to the non-depressed and depressed group, respectively (Figure 1).

The demographics of the participants are listed in Table 1. The SMI and MNA-SF were significantly lower while the rates of sarcopenia and cerebrovascular disease were significantly higher in the depressed group than in the non-depressed group. Mobility, presence of psychological stress or acute disease in the past 3 months, and neuropsychological problems were significantly more severe in the depressed group than in the non-depressed group (Table 1). The results of demographics by sex are shown in Supplemental Table 1.

Binomial logistic regression analysis revealed that the presence of psychological stress or acute disease in the past 3 months, cerebrovascular disease, and sarcopenia were independently associated with depressed mood (Table 2). The neuropsychological problems variable was excluded after considering multicollinearity. For the bi-

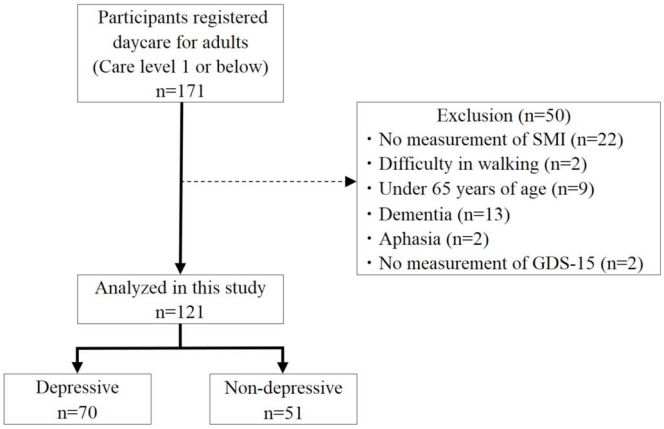


**Figure 1.** Flowchart of the study participants. GDS-15, Geriatric Depression Scale 15; SMI, skeletal muscle mass index.

**Table 1**
Demographics of the participants.

| | Non-depression (n = 51) | Depression (n = 70) | p-value |
|---|---|---|---|
| Age (years) | 78.9 ± 7.4 | 78.8 ± 6.8 | 0.905 |
| Sex, female | 39.2% | 40.0% | 0.931 |
| Body mass Index (kg/m²) | 22.6 ± 3.8 | 21.7 ± 3.5 | 0.199 |
| Grip strength (kg) | 22.9 ± 6.9 | 21.2 ± 7.7 | 0.225 |
| Walking speed (m/s) | 0.8 ± 0.3 | 0.7 ± 0.3 | 0.221 |
| SMI (kg/m²) | 6.5 ± 0.9 | 6.1 ± 0.9 | **0.011** |
| MNA-SF | | | **< 0.001** |
| Normal nutritional status | 64.7% | 14.3% | |
| At risk of malnutrition | 31.4% | 65.7% | |
| Malnourished | 3.9% | 20.0% | |
| Screening item A | | | 0.248 |
| Severe decrease in food intake | 0.0% | 4.3% | |
| Moderate decrease in food intake | 5.9% | 11.4% | |
| No decrease in food intake | 94.1% | 84.3% | |
| Screening item B | | | 0.279 |
| Weight loss greater than 3 kg | 0.0% | 7.1% | |
| Does not know | 7.8% | 8.6% | |
| Weight loss between 1 and 3 kg | 29.4% | 24.3% | |
| No weight loss | 62.7% | 60.0% | |
| Screening item C | | | **0.037** |
| Bed or chair bound | 2.0% | 0.0% | |
| Able to get out of bed/chair, but does not go out | 27.5% | 45.7% | |
| Goes out | 70.6% | 54.3% | |
| Screening item D | | | **0.007** |
| Yes | 25.5% | 50.0% | |
| No | 74.5% | 50.0% | |
| Screening item E | | | **< 0.001** |
| Severe dementia or depression | 15.7% | 92.9% | |
| Mild dementia | 9.8% | 1.4% | |
| No psychological problems | 74.5% | 5.7% | |
| Screening item F | | | 0.097 |
| CC less than 31 | 15.7% | 28.6% | |
| CC 31 or greater | 84.3% | 71.4% | |
| Sarcopenia (AWGS2019) | | | **0.010** |
| Robust | 49.0% | 30.0% | |
| Sarcopenia | 21.6% | 12.9% | |
| Severe sarcopenia | 29.4% | 57.1% | |
| Barthel Index(score) | 93.0 ± 8.5 | 92.1 ± 8.4 | 0.443 |
| Cerebrovascular disease | 41.2% | 62.9% | **0.018** |
| Cardiopulmonary disease | 29.4% | 41.4% | 0.175 |
| Orthopedic disease | 52.9% | 58.6% | 0.538 |
| Intractable neurological disease | 13.7% | 14.3% | 0.930 |
| cancer | 15.7% | 30.0% | 0.069 |
| Diabetes | 19.6% | 22.9% | 0.667 |

A: Has food intake declined over the past 3 months due to loss of appetite, digestive problems, chewing or swallowing difficulties? B: Weight loss during the last 3 months. C: Mobility. D: Has suffered psychological stress or acute disease in the past 3 months? E: Neuropsychological problems. F: Calf circumference (CC) in cm.
The data are presented as the mean ± standard deviation. An unpaired t-test, the Mann-Whitney U test, Fisher's exact test and the $\chi^2$ test were used to study the differences between the depressed and non-depressed groups.
AWGS 2019, Asian Working Group for Sarcopenia 2019; MNA-SF, Mini Nutritional Assessment Short-Form; SMI, skeletal muscle mass index.

**Table 2**
Independent risk factors for depression in older individuals requiring long-term care.

| | Model I | | Model II | |
|---|---|---|---|---|
| | OR (95% CI) | p-value | OR (95% CI) | p-value |
| Sarcopenia | 2.00 (1.26–3.15) | **0.003** | 2.16 (1.31–3.55) | **0.003** |
| MNA-SF Screening item C | – | – | 0.61 (0.27–1.37) | 0.231 |
| MNA-SF Screening item D | – | – | 0.34 (0.14–0.82) | **0.016** |
| Cerebrovascular disease | – | – | 3.08 (1.27–7.48) | **0.013** |

Data are presented as OR, odds ratio; CI, confidence interval; MNA-SF, Mini Nutritional Assessment Short-Form. Screening item C: Mobility. Screening item D: Has suffered psychological stress or acute disease in the past 3 months? Model I: adjusted for age and sex. Model II: adjusted for age and sex.

nomial logistic regression analysis, a post-hoc analysis was performed; for the linear multiple regression analysis using the F-test, the power was 1.00 based on the effect size of 0.335 calculated from the regression equation (Nagelkerke $R^2$ = 0.251) (Table 2 Model II).

After adjusting for confounding factors by multiple regression analysis, the association between the depressive symptoms and

sarcopenia diagnostic factors was evaluated. Among the diagnostic factors for sarcopenia, depression was significantly associated with SMI, but not with grip strength or walking speed (Table 3).

**Table 3**
Association between sarcopenia diagnostic factors and depression.

| | SMI | | Grip strength | | Walking speed | |
|---|---|---|---|---|---|---|
| | β | p-value | β | p-value | β | p-value |
| Model I | -0.23 | **0.007** | -0.11 | 0.149 | -0.11 | 0.228 |
| Model II | -0.27 | **0.003** | -0.11 | 0.165 | -0.07 | 0.447 |

β, standardized regression coefficient; SMI, skeletal muscle mass; Model I: adjusted for age and sex; Model II: adjusted for age, sex, cerebrovascular disease, MNA-SF Screening item C, MNA-SF Screening item D.
MNA-SF, Mini Nutritional Assessment Short-Form; Screening item C: Mobility; Screening item D: Has suffered psychological stress or acute disease in the past 3 months?

## 4. Discussion

This study aimed to investigate the relationship between depressive symptoms and sarcopenia in older individuals requiring long-term care. We found that depressive symptoms were significantly associated with cerebrovascular disease, malnutrition, and sarcopenia. Furthermore, among the diagnostic factors for sarcopenia, depressive symptoms were significantly associated with muscle mass but not with grip strength or walking speed. Previous studies have reported a prevalence of depression in older adults at 28.7%. In this study, the prevalence of depressive symptoms was 57.9%, which was higher than that reported in previous studies. This discrepancy may have been due to the current study population being older than those of previous studies, having multiple chronic diseases, and requiring support or long-term care in their daily lives.

Several reports on the association between depression and cerebrovascular disease were available. Previous studies reported that approximately 33% of patients who had a stroke develop depression due to organic and social factors.[14,15] Depression after stroke is considered a clinically important neuropsychiatric symptom because it adversely affects physical recovery and quality of life, interferes with rehabilitation, and is a significant burden for caregivers. Our results support the findings of previous studies indicating that cerebrovascular disease is associated with depressive symptoms, even in older adults requiring long-term care.

A systematic review reported an independent association between sarcopenia and depression.[7] This study yielded consistent results, finding an independent association between sarcopenia and depressive symptoms even after adjusting for covariates. Furthermore, skeletal muscle mass was the factor most strongly associated with depressive symptoms among the sarcopenia diagnostic items. This finding is comparable to previous studies reporting that skeletal muscle mass is associated with depressive symptoms.[16] The direct mechanism underlying the relationship between skeletal muscle mass and depressive symptoms remains unclear, but the involvement of inflammation and oxidative stress has been suggested.[17] Depressed patients show increased inflammatory agents in the peripheral blood and increased immune cells, such as neutrophils and monocytes.[18] Tumor necrosis factor-alpha (TNF-α) is primarily produced by macrophages and contributes to the production of interleukin-6 and C-reactive protein, which is a chronic inflammatory process in the body.[19] An increase in the TNF-α level due to chronic disease can cause a decrease in muscle mass.[20,21] The results of the present study support the findings of these previous studies, and suggest that depression and skeletal muscle mass may be closely related in older individuals requiring long-term care. However, further research is needed to determine how skeletal muscle mass and depression are affected.

The study has several limitations. First, the small sample size limited the selection of independent variables, and comparisons based on sex did not reveal significant differences in SMI and sarcopenia in women. Furthermore, baseline data were obtained from older adults undergoing outpatient rehabilitation. Therefore, the generalizability of the findings of this study needs to be assessed using data from a larger general population of older adults in need of care. Second, since the GDS-15 is a screening tool for depressive symptoms, the relationship between depression and sarcopenia cannot be clearly established. Third, depressive symptoms may be related to social factors, which warrants further investigation.[22] Fourth, the antecedent loss of muscle mass due to depression may reduce muscle strength and function, which cannot be clarified due to the cross-sectional nature of the study. Detailed nutritional assessment, including serum albumin and inflammatory markers, as well as longitudinal studies are needed to further clarify the relationship between depression and sarcopenia. The results also suggest that depressive symptoms are involved in the exacerbation of sarcopenia. Thus, monitoring depression may lead to the prevention of sarcopenia requiring long-term care.

In conclusion, depressive symptoms were independently associated with cerebrovascular disease, malnutrition, and sarcopenia in older individuals requiring long-term care. Furthermore, depressive symptoms were found to be associated with skeletal muscle mass. Screening for depression, and prophylactic interventions against depressive symptoms to prevent sarcopenia are necessary for older adults requiring long-term care.

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## Conflicts of interest

The authors declare no conflict of interest.

## Supplementary materials

Supplementary materials for this article can be found at http://www.sgecm.org.tw/ijge/journal/view.asp?id=26.

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