Severely Decreased Muscle Mass among Older Patients Hospitalized in a Long-Term Care Ward in Japan

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(Received January 14, 2016)

Summary
Sarcopenia is known to increase the risk of adverse outcomes, including disability, loss of independence, hospitalization, longer length of hospital stay, and mortality, but there is little data about the prevalence of sarcopenia and the factors associated with increased physical dependency and cognitive decline among older patients hospitalized in a long-term care (LTC) ward in Japan. A cross-sectional study was conducted in 79 consecutive patients (34 men, 45 women) with a median age of 81 y hospitalized in an LTC hospital. Sarcopenia was defined according to the recommended algorithm of the Asian Working Group for Sarcopenia. Skeletal muscle mass index (SMI) was assessed by using bioelectrical impedance analysis. Physical dependency and cognitive decline were evaluated by the Functional Independence Measure (FIM). Nutritional status was evaluated by using the Mini Nutritional Assessment-Short Form and daily intake of energy and protein. Multivariate analyses were applied to examine factors associated with increased physical dependency and cognitive decline. Median SMI was 4.9 kg/m² (interquartile range [IQR], 4.0–5.3 kg/m²) in men and 3.3 kg/m² (IQR, 2.9–3.8 kg/m²) in women, showing that all participants had an SMI below the cut-off value. Seventy participants (88.6%) were unable to perform the hand grip strength test, and all participants were unable to perform the gait speed test. Multivariate analysis showed that oral nutritional access and daily energy intake were associated both with physical and cognitive level (p<0.05).

Key Words
Japanese, long-term care hospital, older people, sarcopenia

Japan is facing serious challenges related to aging of the population. The proportion of aged in Japan, which is the highest in the world, was reported to be 26.0% in 2015. The aging process influences a decline in skeletal muscle mass and function, leading to an increase in the number of older individuals requiring long-term care (LTC) and functional training. LTC hospitals and facilities (e.g., nursing homes) face problems concerning increased physical dependency and cognitive decline (1, 2).

Sarcopenia—defined as loss of muscle mass and strength and/or reduced physical performance (3)—is known to increase the risk of adverse outcomes, including disability, loss of independence, hospitalization, length of hospital stay, and mortality (4–7). Health care costs can be decreased if a reduction in sarcopenia is achieved (8). Although the mechanism of sarcopenia remains unclear, the European Working Group on Sarcopenia in Older People categorized sarcopenia into primary sarcopenia (age-related sarcopenia) and secondary sarcopenia (activity-, disease-, or nutrition-related sarcopenia) (3). Previous studies have reported the prevalence of sarcopenia to be 1–29% in community-dwelling populations, 14–33% in nursing homes, and 10–21% in acute-care hospitals (9–11). However, no previous studies have discussed the prevalence of and factors associated with sarcopenia among older patients at LTC hospitals.

How prevalent is sarcopenia among older patients at LTC hospitals in Japan? Is sarcopenia associated with increased physical dependency and cognitive decline in such individuals? To examine these clinical questions, a cross-sectional study was conducted in older patients hospitalized in an LTC ward in Japan.

MATERIALS AND METHODS

Subjects. A cross-sectional study was conducted in consecutive inpatients who were admitted to an LTC ward at Saku Hospital in April 2015. Saku Hospital, located in Fukuoka City with a population of approximately 1.46 million, among which 24.1% are aged over 65 y, is a locally based hospital with an LTC ward financed by health insurance.

All patients underwent clinical assessments including demographic and medical data, coexisting diseases,
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Table 1. Demographic characteristics of all patients, divided by sex.

| Variables                                | Total (n=79) | Male (n=34) | Female (n=45) | p-value |
|------------------------------------------|--------------|-------------|---------------|---------|
| Age (y), median [IQR]                    | 81 [71–88]   | 74 [65–81]  | 84 [79–91]    | <0.001* |
| Length of stay (d), median [IQR]         | 985 [464–1,660] | 1,053 [480–1,802] | 889 [444–1,445] | 0.705*  |
| BMI (kg/m²), median [IQR]                | 19.4 [17.6–21.5] | 19.5 [17.4–21.4] | 19.4 [17.5–21.6] | 0.643*  |
| SMI (kg/m²), median [IQR]                | 3.9 [3.1–5.0] | 4.9 [4.0–5.3] | 3.3 [2.9–3.8] | <0.001* |
| FMI (kg/m²), median [IQR]                | 7.4 [5.0–9.6] | 7.2 [4.7–9.5] | 7.6 [5.1–9.9] | 0.338*  |
| Coexisting disease, n (%)                |              |             |               |         |
| Cerebrovascular disease                  | 56 (70.9)    | 25 (73.5)   | 31 (68.9)     |         |
| Chronic heart failure                    | 31 (39.2)    | 10 (29.4)   | 21 (46.7)     |         |
| Chronic liver disease                    | 7 (8.9)      | 2 (5.9)     | 5 (11.1)      |         |
| CKD                                      | 24 (30.4)    | 10 (29.4)   | 14 (31.1)     |         |
| Collagen disease                         | 3 (3.8)      | 3 (8.8)     | 0 (0.0)       |         |
| COPD                                     | 5 (6.3)      | 2 (5.9)     | 3 (6.7)       |         |
| DM                                       | 20 (25.3)    | 9 (26.5)    | 11 (24.4)     |         |
| Dyslipidemia                             | 20 (25.3)    | 9 (26.5)    | 11 (24.4)     |         |
| Hypertension                             | 55 (69.6)    | 22 (64.7)   | 33 (73.3)     |         |
| Malignancy                               | 4 (5.1)      | 2 (5.9)     | 2 (4.4)       |         |
| Neuromuscular degenerative disease       | 6 (7.6)      | 5 (14.7)    | 1 (2.2)       |         |
| Parkinson’s disease                      | 8 (10.1)     | 0 (0.0)     | 8 (17.8)      |         |
| Oral intake, n (%)                       |              |             |               |         |
| Yes                                      | 13 (16.5)    | 8 (23.5)    | 5 (11.1)      | 0.144b  |
| No                                       | 66 (83.5)    | 26 (76.5)   | 40 (88.9)     |         |
| Energy intake (kcal/d), median [IQR]     | 1,000 [900–1,200] | 1,200 [975–1,200] | 1,000 [850–1,200] | 0.016* |
| Protein intake (g/d), median [IQR]       | 46 [40–50]   | 49 [39–55]  | 45 [40–50]    | 0.390*  |
| FIM-M, median [IQR]                      | 13 [13–13]   | 13 [13–14]  | 13 [13–13]    | 0.067*  |
| FIM-C, median [IQR]                      | 5 [5–7]      | 5 [5–14]    | 5 [5–5]       | 0.067*  |
| HG (kg), median [IQR]                    | 0 [0–0]      | 0 [0–0]     | 0 [0–0]       | 0.142*  |
| JCS, n (%)                               |              |             |               |         |
| Awake                                    | 39 (49.4)    | 18 (52.9)   | 21 (48.7)     | 0.881b  |
| Temporary awakening with stimulus        | 23 (29.1)    | 8 (23.5)    | 15 (33.3)     |         |
| Unconscious                              | 17 (21.5)    | 8 (23.5)    | 9 (20.0)      |         |
| MNA-SF, median [IQR]                     | 7 [5–8]      | 7 [4–8]     | 7 [5–8]       | 0.337*  |
| Laboratory data, median [IQR]            |              |             |               |         |
| Albumin (mg/dL)                          | 3.2 [2.7–3.4] | 3.0 [2.7–3.4] | 3.3 [2.7–3.4] | 0.709*  |
| Hemoglobin (g/dL)                        | 12.1 [10.7–13.5] | 13.0 [11.2–14.4] | 11.2 [10.5–12.9] | 0.019*  |
| CRP (mg/dL)                              | 0.5 [0.1–2.2] | 1.1 [0.3–2.4] | 0.4 [0.1–1.8] | 0.245*  |
| TLC (count)                              | 1.640 [1.182–2.226] | 1.548 [1.305–2.368] | 1.690 [1.125–2.175] | 0.809*  |

BMI: body mass index. SMI: skeletal muscle mass index. FMI: fat mass index. CKD: chronic kidney disease. COPD: chronic obstructive pulmonary disease. DM: diabetes mellitus. FIM: Functional Independence Measure. HG: hand grip strength. JCS: Japan Coma Scale. MNA-SF: Mini Nutritional Assessment–Short Form. CRP: C-reactive protein. TLC: total lymphocyte count.

nutritional status, activities of daily living (ADLs), cognitive level, consciousness level, length of hospital stay, body composition, hand grip strength, gait speed, and laboratory data. Trained nurses evaluated anthropometric measurements, while trained rehabilitation therapists assessed hand grip strength and gait speed. Consciousness level was evaluated by using the 10-grade Japan Coma Scale (JCS) (12, 13), with scores of 0 and I (1, 2, 3) defined as awake, a score of II (10, 20, 30) defined as temporary awakening in response to stimulation, and a score of III (100, 200, 300) defined as unconscious. Nutritional status was evaluated by using the Mini Nutritional Assessment-Short Form (14–16) via interviews conducted by two trained registered diетitians. Daily energy and protein intake were calculated by multiplying the ratio of the actual food intake and provided food to provided energy and protein. Actual food intake was estimated based on the ingestion ratio of staple food, side dishes, and nutritional supplements described in the medical records by nurses and registered dietitians. For example, a patient who ate 30% of provided food on average per week was estimated to take 30% of provided energy and protein. For patients on enteral nutrition, we recorded actual provision of energy and protein. ADLs, or physical dependency, were evaluated by using the Functional Independence Measure (FIM) (17) by trained rehabilitation therapists. The FIM is one of the most common tools to assess ADLs, and includes 13 lower-order items regarding the motor domain (FIM-M) and 5 lower-order items regarding the cognitive domain (FIM-C). The FIM-M score ranges from 13 to 91, while the FIM-C score ranges from 5 to 35. Body composition, including skeletal muscle mass index (SMI) and fat mass index, was assessed by using bioelec-
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Diagnosis of sarcopenia. Sarcopenia was defined according to the recommended algorithm of the Asian Working Group for Sarcopenia (AWGS) (18). We considered that a participant had sarcopenia when their SMI was <7.0 kg/m² in men or <5.7 kg/m² in women, with either gait speed <0.8 m/s or hand grip strength <26 kg in men or <18 kg in women.

Statistical analysis. Statistical analyses were performed with IBM SPSS Statistics 21 software. Nonparametric data were expressed as median and 25–75 percentile (interquartile range [IQR]). The Chi-square test and the Mann-Whitney U test were used to analyze the differences between the two groups stratified by sex. Multiple linear regression analysis was used to determine which clinical variables independently associated with SMI, FIM-M and FIM-C after being adjusted for age, sex and length of hospital stay. Values of \( p < 0.05 \) were considered statistically significant.

Ethics. The ethics committee of the Saku Hospital approved this study (approval number: 20150125). Informed consent was obtained from the participants or the next of kin.

RESULTS

A total of 79 patients (34 men, 45 women) with a median age of 81 y (IQR, 71–88 y) were included in this study. Table 1 shows the demographic characteristics of the study participants. Median SMI was 4.9 kg/m² (IQR, 4.0–5.3 kg/m²) in men and 3.3 kg/m² (IQR, 2.9–3.8 kg/m²) in women, showing that all participants had an SMI below the cut-off value for sarcopenia (Fig. 1). Median hand grip strength was 0 kg (IQR, 0–0 kg) in participants who were able to perform the evaluation. Seventy participants (88.6%) were unable to perform the hand grip strength test, and all participants were unable to perform the gait speed test due to reduced ADLs and cognitive decline. In these patients, a definite diagnosis of either sarcopenia or no sarcopenia was not possible, lacking at least one of the AWGS criteria.

Table 2 shows the incidence of coexisting diseases and associations with SMI using a linear regression analysis after adjusting for age, sex and length of stay.

| Variables                        | n (%) | Beta | p-value |
|----------------------------------|-------|------|---------|
| Cerebrovascular disease          | 56 (70.9) | 0.20 | 0.105   |
| Chronic heart failure            | 31 (39.2) | 0.28 | 0.835   |
| Chronic liver disease            | 7 (8.9) | -0.13 | 0.271   |
| Chronic kidney disease           | 24 (30.4) | 0.13 | 0.245   |
| Collagen disease                 | 3 (3.8) | -0.28 | 0.846   |
| COPD                             | 8 (10.1) | 0.30 | 0.022   |
| Diabetes mellitus                | 20 (25.3) | -0.08 | 0.519   |
| Dyslipidemia                     | 20 (25.3) | -0.08 | 0.488   |
| Hypertension                     | 55 (69.6) | -0.09 | 0.496   |
| Malignancy                       | 4 (5.1) | -0.09 | 0.402   |
| Neuromuscular degenerative disease | 6 (7.6) | -0.17 | 0.247   |
| Parkinson’s disease              | 8 (10.1) | -0.00 | 0.996   |

SMI: skeletal muscle mass index. COPD: chronic obstructive pulmonary disease.

Skeletale impedance analysis (InBody S10; Biospace Co. Ltd, Tokyo, Japan).

Fig. 1. Frequency distribution of skeletal muscle mass index (SMI) in each gender. Closed column: men, open column: women.

Table 2. Incidence of coexisting disease, and association with SMI using a linear regression analysis after adjusting for age, sex and length of stay.
significant association with SMI after adjusting for age, sex, and length of hospital stay. There were no factors significantly associated with SMI. Body mass index, oral nutritional access, energy intake, FIM-C score, hand grip strength, JCS score, and albumin level were significantly associated with FIM-M score. Oral nutritional access, energy and protein intake, FIM-M score, hand grip strength, and JCS score were significantly associated with FIM-C score.

**DISCUSSION**

This study addressed two clinical questions concerning the prevalence of sarcopenia and the factors associated with increased physical dependency and cognitive decline among older patients hospitalized in an LTC ward. First, severely decreased muscle mass was prevalent in this study population. Second, oral nutritional access and daily energy intake were associated with maintenance of ADLs and cognitive level.

To our knowledge, no previous survey has attempted to estimate the prevalence of sarcopenia in LTC hospitals according to the AWGS definition. Most geriatric patients in our study were immobile and malnourished, and had an extremely low cognitive level. The negative effects of immobilization, malnutrition, and cognitive decline in our population may contribute to the serious depletion of muscle mass, leading to an extremely high prevalence of sarcopenia compared with previous studies in various clinical settings: 1–29% in community-dwelling populations, 14–33% in nursing homes, and 10–21% in acute-care hospitals (9–11).

Polypathia, or the simultaneous occurrence of several comorbidities, is another possible cause of sarcopenia. History of stroke was detected in 70.9%, hypertension in 69.5%, chronic heart failure in 39.2%, and COPD in 10.1% of participants. COPD was found to be significantly associated with SMI after adjusting for age, sex, and length of hospital stay, though it was a small sample size. Chronic disease and inflammation are well-recognized risk factors for sarcopenia; they have been shown to reduce food intake as well as body weight and muscle mass and function, thereby contributing to development of malnutrition and sarcopenia in older individuals (19). With the development of malnutrition and worsening of sarcopenia, a vicious circle develops in which recurrent illness leads to further inflammatory response, malnutrition, and sarcopenia (20).

Oral nutritional access and daily energy intake were found to be associated with ADLs and cognitive level. Older individuals suffering from dementia are at increased risk of malnutrition owing to various nutritional problems. As dementia progresses, an individual may experience increasing difficulties in eating and drinking safely. Difficulties in eating and drinking, or dysphagia, are common and associated with malnutrition and risk of death among older individuals who require LTC (21). Furthermore, malnutrition is associated with poor physical function (22), which can lead to secondary sarcopenia (activity- or nutrition-related sarcopenia) (1).

Given the high prevalence of sarcopenia among older patients at an LTC hospital, it is imperative to develop and implement evidence-based interventions into clinical practice (23). Interventions to prevent or reduce sarcopenia include exercise interventions, or rehabilitation, to increase muscle strength and improve physical performance, and nutritional interventions to increase protein synthesis, or a combination of both. The concept of “rehabilitation nutrition,” a combination of both rehabilitation and nutritional care management, may improve outcomes in older disabled patients with malnutrition and sarcopenia (22). Moreover, as one of the authors reported recently, nutritional supplements may improve ADLs in older disabled patients with sarcopenia.

Table 3. Factors associated with SMI, motor FIM and cognitive FIM using linear regression analysis adjusted for age, sex, and length of stay.

|          | SMI | FIM-M | FIM-C |
|----------|-----|-------|-------|
| **Beta (SE)** | p-value | Beta (SE) | p-value | Beta (SE) | p-value |
| BMI | 0.079 (0.042) | 0.444 | 0.242 (0.296) | 0.035 | 0.111 (0.250) | 0.332 |
| SMI | — | — | — | — | — | — |
| FMI | −0.150 (0.013) | 0.147 | −0.135 (0.961) | 0.341 | 0.015 (0.792) | 0.916 |
| Oral access | 0.115 (0.333) | 0.267 | 0.063 (0.996) | 0.591 | 0.012 (0.079) | 0.918 |
| Energy intake | 0.183 (0.001) | 0.096 | 0.613 (1.895) | 0.000 | 0.618 (1.535) | 0.000 |
| Protein intake | −0.006 (0.013) | 0.957 | 0.262 (0.004) | 0.033 | 0.477 (0.003) | 0.000 |
| FIM-M | −0.099 (0.015) | 0.341 | 0.211 (0.090) | 0.067 | 0.347 (0.071) | 0.002 |
| FIM-C | 0.011 (0.019) | 0.916 | 0.704 (0.102) | 0.000 | 0.679 (0.069) | 0.000 |
| HG | −0.032 (0.044) | 0.764 | 0.260 (0.324) | 0.027 | 0.271 (0.266) | 0.019 |
| JCS | 0.026 (0.050) | 0.807 | −0.242 (0.360) | 0.040 | −0.420 (0.277) | 0.000 |
| MNA-SF | 0.016 (0.051) | 0.882 | 0.149 (0.367) | 0.210 | 0.120 (0.303) | 0.305 |
| Alb | −0.149 (0.243) | 0.183 | 0.268 (1.897) | 0.029 | 0.125 (1.488) | 0.312 |

BMI: body mass index; SMI: skeletal muscle mass index; FMI: fat mass index; FIM: Functional Independence Measure; HG: hand grip strength; JCS: Japan Coma Scale; MNA-SF: Mini Nutritional Assessment–Short Form; Alb: serum albumin level.
who require rehabilitation (24).

This study had several limitations. First, the small sample size and single study setting might decrease the accuracy of the statistical analysis and limit the generalization of the results. Second, as this was a cross-sectional study, no cause-and-effect relationships could be derived among the variables. Third, as the subjects in the study were found to be all sarcopenic, there was no analysis of the comparison with the control group (no sarcopenia). Fourth, in many study participants, a definite diagnosis of either sarcopenia or no sarcopenia was not possible, lacking diagnostic accuracy for sarcopenia.

In conclusion, severely decreased muscle mass was prevalent in older patients hospitalized in an LTC ward in Japan. Oral nutritional access and daily energy intake were associated with maintenance of ADLs and cognitive level. Further studies with a large sample size and longitudinal follow-up are needed to corroborate the results of this study and allow their application in the clinical setting.

Ethics
The protocol for the study has been approved by the Institutional Review Board of Saku Hospital within which the work was undertaken, and it conforms to the provisions of the Declaration of Helsinki. The subjects who require rehabilitation in a way to determine the scale. The reliability of the functional independence measure: a quantitative review. Arch Phys Med Rehabil 77: 1226–1232.

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