Original Article

Longitudinal changes and body composition assessment using bioelectrical impedance in elderly patients with mild disequilibrium and different care needs

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Abstract. [Purpose] This study involved performing longitudinal measurements of muscle mass in elderly patients with mild disequilibrium using a body composition meter. The rate of change and characteristics were determined according to the level of care needed. [Participants and Methods] Bioelectrical impedance was used to measure body composition in 20 elderly females in Care Needs Category 1 (n=10) and 2 (n=8); body composition was measured every 3 months for 1 year. [Results] Compared to Category 1, the muscle mass at each body site was lower in Category 2 and the muscle mass of the whole body and thighs in Category 2 decreased throughout the year. [Conclusion] Muscle mass in elderly patients needing assistance depended on the level of care, as suggested by the decrease in muscle mass in the whole body and thighs in Category 2 over time. In addition, effective rehabilitation intervention for the trunk is important.

Key words: Elderly with mild disequilibrium, Body composition, Muscle mass

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INTRODUCTION

In Japan, as aging progresses, involvement of elderly individuals in the rehabilitation field is increasingly necessary1). Moreover, among physiotherapy evaluations, assessment of activities of daily living (ADL), body composition and muscle strength are becoming more important.

With regard to the body composition, Lexell et al. examined young and elderly human cadavers and reported that the cross-sectional area of the quadriceps muscle of elderly individuals was significantly lower than that of young people2). From this, it is considered important to evaluate the muscle mass of elderly, but although there have been many studies on muscle strength and similar body features, published literature on measuring body composition based on muscle mass is limited. In this study, the muscle mass of older people was evaluated.

Although some reports are available3, 4), only representative values were given, but muscle mass has not been examined by body site. Moreover, various measuring equipment has also been used to measure muscle mass. The European Working Group on Sarcopenia in Older People has provided its definition of sarcopenia through computed tomography (CT), magnetic resonance imaging (MRI), dual-energy X-ray absorptiometry, and bioimpedance analysis (BIA). BIA is the recommended method, but it is currently not practical in many clinical settings. BIA is often used because of its ease of use, high reproducibility, and less restrictions such as posture. BIA is based on the electrical conductivity of living tissue, which contains a large amount of fluids, to impede electrical current flow, which is measured by applying a weak radio frequency current to
the living body. The impedance of tissues, moisture, fats, muscles, etc., is varied. Therefore, in this study, we evaluated body composition based on the difference in impedance⁵, ⁶.

In Japan, Person Requiring Support is classified into two in Nursing Care Insurance Law⁷. In this research, we define Person Requiring Support as the elderly with mild disequilibrium. Elderly with mild disequilibrium categorized under Care Needs Category 1 (C1) can perform basic ADL, whereas those in Care Needs Category 2 (C2) can perform tasks similar to those in C1 but requires more help with their ADL functions. In addition, there are research reports⁸ that women account for 70% among elderly with mild disequilibrium. In a study using BIA⁹, the muscle mass of the whole body, thighs, lower legs, and trunk was measured in elderly individuals with mild disequilibrium, and the muscle mass in each part except the lower leg of participants under C2 was significantly lower than those under C1.

Previous cross-sectional studies based on the body composition are scarce, but no longitudinal studies have been reported. Many of these studies only compare young people with elderly individuals, while some targeted only healthy elderly people. Therefore, the purpose of this study was to measure the muscle mass of elderly with mild disequilibrium regularly and longitudinally, compare the results by degree of care needs, and clarify the change and features.

**PARTICIPANTS AND METHODS**

The participants were 20 elderly females with mild disequilibrium who were classified under C1 and C2 of the Japanese long-term care insurance system and who had weekly care rehabilitation. Based on the degree of nursing care needed, 10 females were in C1 and the other 10 in C2. There were excluded those with cerebrovascular disease and those with cognitive deficits. Data of 18 participants were eventually collected in 1 year, that is, 10 under C1 and 8 under C2. The study was conducted in an orthopedic clinic.

As an ethical consideration, prior to the start of the study, all participants were sufficiently given written and verbal explanations of the purpose and content of this study, and they provided informed consent. In addition, this study was conducted with the approval of the International University of Health and Welfare Ethics Committee (approval number: 14-Ig-60).

The data collection period was set for 1 year from December 2015 to December 2016. The evaluation period covers five measurements of physical function: starting month (1M), 3 months (3M), 6 months (6M), 9 months (9M), and 12 months (12M). For rehabilitation intervention, the participants collectively performed exercises under the guidance of physiotherapists for 1 hour once a week. Both categories had the same exercise regimen.

For the measurement of body composition, Physion MD (Nippon Shooter Co., Ltd.), which is a BIA-type body composition meter, was used. Physion MD is a device that can measure muscle mass by site through BIA, which is a four-limb 12-lead electrode method performed in the supine position. Impedance measurement was performed at a frequency of 50 kHz and current of 500 μArms, and the range of impedance was 10 to 1,500 Ω. Accuracy was ± 1% ± 0.5 Ω (50 to 1,000 Ω) or ± 2% ± 0.5 Ω (other impedance range), and the resolution capability was 0.1 Ω. In terms of measurement accuracy, Physion MD has a strong correlation with muscle mass at 0.9 or more as measured by MRI, and Physion MD’s estimation of the limb muscle mass is equivalent to the limb muscle diagnosis by MRI.

For the measurement items, the muscle mass of the whole body, left and right thighs, left and right lower legs, and right and left trunk were measured, and the sum of the muscle mass of the left and right thighs, lower legs, and trunk was obtained.

For measurement conditions, height and weight were obtained before the actual muscle mass measurement, which was the period before rehabilitation intervention to keep the condition of all participants constant. Measurement position was set in the supine position, and measurement was carried out after the participants have rested for about 5 min. In addition, at the time of the measurement, the participants were instructed to remove any worn jewelry or accessories (such as watches, jewelry, etc.). Participants with embedded electronic devices such as pacemakers were excluded.

For each item of body composition, the mean and standard deviation values of C1 and C2 for each evaluation month were calculated. The rate of data change for the second and later evaluation months from the starting month was calculated. Statistical analysis was carried out. To determine the attribute of each participant, Mann-Whitney U test was used for each item of the two categories. For each item of body composition, the Friedman test was used in both groups. When a significant difference was observed, multiple comparisons were made using Wilcoxon’s signed rank test. In each evaluation month, comparison and examination were conducted using Mann-Whitney U test for both categories. SPSS version 23 for Windows was used as statistical software, and the significance level was set at 5%.

**RESULTS**

The basic attributes of the participants are shown in Table 1. There was no significant difference between C1 and C2 in all items of basic attributes. Table 2 shows the muscle mass for each part based on the care category, and the change rate is shown in Table 3.

The Friedman test showed a significant difference between the lower leg muscle mass in C1 and the muscle mass of the whole body/thighs in C2 (Table 2). For the change rate, a significant difference was observed only in the whole body muscle mass of C2 (Table 3). As a result of multiple comparisons, significant differences were observed between 1 M and 9 M in the whole body muscle mass of C2, but no significant differences in other months.
As a result of comparing both categories, the muscle mass of the trunk at 6 M was significantly lower in C2 than that in C1 (Table 2). A significant difference was found between 1 M and 12 M in terms of whole body muscle mass and lower leg muscle mass based on the rate of change of muscle mass at each site among caregiving degrees (Table 3).

### DISCUSSION

This study measures muscle mass by site through the BIA method using Physion MD as body composition measurement device. A previous study\(^{10}\) reported that the amount of muscle mass can be estimated. There are different types of BIA devices, but most of the devices are set to stand for a certain period of time; hence, patients should be in a stable standing position. However, because the Physion MD can be used in the supine position, there is no restriction on posture; hence, it can be used with convenience during measurement. In addition, because of its high reliability in previous studies, it was considered useful as a clinical body composition evaluation device.

In terms of the body composition by each category of care, the lower leg muscle mass was found to be necessary in C1, and the muscle mass of the whole body and thighs were found to be significantly different throughout the year in C2. The whole body muscle mass in C2 was significantly reduced at 9 M than at 1 M. Significant differences were found in the lower leg muscle mass of C1, but the actual muscle mass itself has increased. However, the muscle mass of the whole body and thighs of C2 were found to be significantly different and decreased sequentially. From this it is suggested that muscular mass of the lower leg and the trunk is maintained in the elderly with mild disequilibrium but it is suggested that muscle mass of the whole body and thigh decreases throughout the year in C2 compared with C1.

Comparing the muscle mass of each site based on caregiving degrees, there was no significant difference in the muscle mass of the whole body, thighs, legs, and knees between the two categories at any evaluation month. However, the muscle mass of the trunk was significantly lower at 6 M in C1 than in C2. From this result, differences in nursing care levels may oc-

### Table 1. Participant attributes

|                    | Height (cm) | Weight (kg) | Age (years) | BMI (kg/m²) |
|--------------------|-------------|-------------|-------------|-------------|
| Care Needs Category 1 | 147.2 ± 4.0 | 50.5 ± 6.8  | 80.1 ± 5.2  | 23.2 ± 2.3  |
| Care Needs Category 2 | 150.4 ± 5.8 | 55.2 ± 8.7  | 81.6 ± 5.9  | 24.3 ± 2.7  |

Mean ± standard deviation. BMI: body mass index.

### Table 2. Muscle mass by site of Care Needs Categories 1 and 2 (kg)

|                    | Whole body | Thigh | Lower leg | Trunk |
|--------------------|------------|-------|-----------|-------|
|                    | C1         | C2\(^*\) | C1         | C2\(^*\) | C1\(^*\) | C2 | C1         | C2 |
| 1M                 | 16.2 ± 2.2 | 15.3 ± 2.7\(^a\) | 5.1 ± 0.8  | 4.9 ± 0.9  | 2.5 ± 0.4  | 2.4 ± 0.4  | 6.9 ± 1.0  | 6.4 ± 1.0 |
| 3M                 | 16.3 ± 2.1 | 15.0 ± 1.8  | 5.2 ± 0.7  | 4.8 ± 0.7  | 2.6 ± 0.6  | 2.5 ± 0.5  | 7.0 ± 1.1  | 6.3 ± 0.6  |
| 6M                 | 15.9 ± 1.8 | 14.6 ± 1.8  | 5.0 ± 0.7  | 4.7 ± 0.8  | 2.6 ± 0.4  | 2.5 ± 0.4  | 6.6 ± 0.8  | 5.8 ± 0.8\(^*\) |
| 9M                 | 16.1 ± 2.5 | 14.3 ± 2.0\(^a\) | 5.0 ± 0.8  | 4.6 ± 0.8  | 2.5 ± 0.5  | 2.4 ± 0.5  | 6.8 ± 1.2  | 5.9 ± 0.7  |
| 12M                | 16.2 ± 2.1 | 14.4 ± 1.8  | 5.1 ± 0.8  | 4.5 ± 0.6  | 2.8 ± 0.5  | 2.3 ± 0.5  | 6.7 ± 1.0  | 6.1 ± 0.6  |

Care Needs Category 1: C1, Care Needs Category 2: C2.

\(^*\)Significant difference between degree of care, p<0.05.

\(^a\)There is a significant difference in terms of month, p<0.05.

\(^*\)Significant difference over the year, p<0.05.

### Table 3. Change rate of muscle mass by site of Care Needs Categories 1 and 2 (%)

|                    | Whole body | Thigh | Lower leg | Trunk |
|--------------------|------------|-------|-----------|-------|
|                    | C1         | C2\(^*\) | C1         | C2\(^*\) | C1\(^*\) | C2 | C1         | C2 |
| 1M→3M              | 1.1        | ~2.0   | 0.8       | ~3.5   | 4.3       | 1.0 | 0.5       | ~2.4 |
| 1M→6M              | ~1.8       | ~4.7   | ~3.0      | ~5.1   | 7.0       | 4.1 | ~4.4      | ~9.6 |
| 1M→9M              | ~0.7       | ~7.0   | ~1.9      | ~7.7   | 1.4       | ~2.5 | ~2.3      | ~8.4 |
| 1M→12M             | ~0.1       | ~6.3\(^*\) | ~0.1     | ~7.9   | 10.3      | ~5.7\(^*\) | ~3.8      | ~5.9 |

Care Needs Category 1: C1, Care Needs Category 2: C2.

\(^*\)Significant difference between degree of care, p<0.05.

\(^a\)There is a significant difference in terms of month, p<0.05.

\(^*\)Significant difference over the year, p<0.05.

As a result of comparing both categories, the muscle mass of the trunk at 6 M was significantly lower in C2 than that in C1 (Table 2). A significant difference was found between 1 M and 12 M in terms of whole body muscle mass and lower leg muscle mass based on the rate of change of muscle mass at each site among caregiving degrees (Table 3).
cur based on the muscle mass of the trunk of elderly individuals, which also depend on the degree of care needed. In addition, the trunk muscle mass was low in C2, and a significant difference was observed between the muscle mass of the whole body and thighs in C2, which changes throughout the year; hence, the difference possibly depends on the degree of care needed. However, muscle support may be kept on the lower leg, which slightly influences the degree of care needed.

A previous study on body composition targeted approximately 10,000 healthy Japanese people in their teens through the 1990s. According to that study, muscle mass of the whole body, thighs, and quadriceps tend to decrease in both men and women age 50 to 60 years, but the trunk muscle mass is consistent in women after age 60. However, the muscle mass of the lower legs is said to be almost constant for both genders. In addition, as a feature of muscle mass due to aging, a study reported that the decrease in muscle mass is larger in women than in men, and in terms of muscle mass decrease, the order is as follows: lower limbs, whole body, upper limbs, and trunk. Muscle mass is evaluated in both genders by age, which is said to be a feature in cross-sectional change in age.

The results of this study are limited as the participants were elderly females with mild disequilibrium, but there was no difference in attributes. Given the small sample size and longitudinal design, we think that simple comparison is difficult.

From this study, the muscle mass of the lower thigh may be preserved in elderly individuals with mild disequilibrium, which often maintains ADL and mobility. In other words, the lower leg muscle mass is important in maintaining ADL ability and mobility. By nursing care level, the muscle mass of each body site in C1 is at the same level, whereas in C2, the muscle mass of the whole body and thighs are decreasing, in which the whole body muscle mass is significantly lowered. In addition, 50% of the whole body muscle mass was reported equivalent to the trunk muscle mass, and this finding was supportive of a previous study that trunk muscle mass was significantly lower in C2. Since the trunk muscles are considered to have many antigravity muscles, the decrease in posture-holding ability was thought to be due to the decrease in trunk and thigh muscle mass and decrease in basic movement ability. As a result, risk of falls may be higher in C2 than in C1. A study found that the risk of death decreases with increasing muscle mass, and the importance of evaluating muscle mass is considered.

Evaluation of muscle mass and muscle strength as features of body composition is important in elderly with mild disequilibrium. Furthermore, in such elderly, considering the characteristics of the muscle mass by site, exercise therapy not only of the lower limbs but also of the trunk appeared to be useful.

The limit of this research is that there are fewer participants and factors that require nursing care cannot be specified. In the future, it is considered necessary to consider continuous measurement and other items.

Conflict of interest

The author has no conflict of interest to disclose in connection with this thesis.

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