ORIGINAL

# Skeletal muscle mass of old Japanese women suffering from walking difficulty in nursing home

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**Abstract : By using 24 hour urinary creatinine levels, skeletal muscle mass (kg), its rate (%) of body weight and creatinine height index (%) were determined in old Japanese women suffering from walking difficulty in nursing home and compare with those of young university students. Those of old subjects showed approximately 30-50%, 36-44% and 44-46% of young subjects, respectively. It is suggested that these values are important and useful biomarkers for the planning and the achievement of rehabilitation program for the maintaining and restoring skeletal muscle mass and for the careful support by registered care workers to aged persons. J. Med. Invest. 65 : 122-125, February, 2018**

***Keywords*** **:** *Skeletal muscle mass, Old Japanese women, Nursing home*

## INTRODUCTION

Population ageing is recently a common phenomenon in the developed countries including Japan. This has major consequences for society and in particular for health and care service. Although ageing is not necessarily synonymous with illness, infirmity or frailty, it does correlate with disability, impairment and bedridden.

Skeletal muscle (SM) plays a central role in many biological functions, such as movement and metabolism. Loss of muscle mass (sarcopenia) is prevalent in older adults (1) and represents an impaired state of health with mobility disorders, increased risk of falls and fractures, impaired ability to perform activities of daily living (ADL), disabilities and loss of independence (2-5). Based on common clinical experience, a high prevalence and incidence of sarcopenia among older participants living in nursing homes may be expected. Despite a growing interest of scientific community to such condition, information on sarcopenia in nursing homes and its relation to physical function is still lacking. Therefore, understanding SM mass (SMM) of old persons who are very high risk for bedridden is important to provide the adequate rehabilitation and the proper nursing care and to prevent bedridden state.

Although magnetic resonance imaging (MRI) and dual-energy X-ray absorptiometry (DXA) are the gold standard to estimate SMM, those methods are very expensive and not routinely applicable in nursing homes. Bioelectrical impedance (BIA) is a safe, noninvasive, portable, and reliable method to measure passive electrical characteristics of living organisms. However, use of regression models derived in healthy individuals to predict body composition in patients with various diseases is not recommended (6, 7). In addition, an important limitation is measurement differences between BIA devices from different manufactures (6, 8). Therefore, we used 24 h creatinine excretion as measure of total-body SMM, because urinary creatinine is likely proportional to SMM and a reliable measure of SMM in patients with advanced renal failure, in children and adolescents, in elderly people, and in patients with wasting conditions (9-14). In this pilot study, SMM of old Japanese women suffering from working difficulty in nursing home was measured and compared with those of 20-25 old young generation.

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## MATERIALS AND METHODS

### *Subjects*

Thirteen healthy university students (6 male and 7 female, 21-24 years old) who presumably has maximum SMM and old persons (4 female, 82-93 years old) suffering from walking difficulty with non-functional ambulatory in nursing home were recruited in this study. As a result of loss of muscle mass, the older person in nursing home is more at risk of adverse health outcomes that can result in bedridden state. Therefore, criteria of old persons in this study is that their movement is completely depend on the help by care workers and the use of wheelchair. Four aged women were carefully taken care in food intake, movement, excretion and others mainly by registered care workers. None of the young subjects were engaged in high levels of exercise training or were taking any medications just before or during the study. Routine blood studies, including electrolytes, liver tests, and hematologic indexes confirmed the health status of each subject before entry into the protocol.

### *Measurement of SMM*

Each subject collected two 24 h urine samples at inclusion on consecutive 2 days. Creatinine excretion was calculated as the mean of the two 24 h urine collections. SMM was calculated from 24-h urinary creatinine amount based on this equation (SMM= 21.8×Cr) (12). This equation indicates that creatinine excretions of 1.0 g/d and 2.0 g/d represent 21.8 kg and 43.6 kg SMM, respectively. Creatinine height index (CHI) was calculated from the following formula :

CHI= 24-hour urine creatinine excretion (mg)/ expected 24-hour urine creatinine excretion (23 mg/kg in male and 18 mg/kg in

female) × 100.

Estimated nitrogen balance was calculated as the difference between total nitrogen intake and total nitrogen output in the urine. Nitrogen intake was calculated from the nitrogen provided in feeds for each subject. The following formula was used in calculating the nitrogen balance : Nitrogen balance = 24 hour protein intake/6.25-(24 hour urinary nitrogen excretion/0.8).

Putative intestinal absorption rate of nitrogen, sodium, calcium and phosphorus balance were determined as urinary excretion rate (%) among the amount of oral intake from food.

*Statistical analysis*

Data were expressed as the mean ± SD of the each subjects of young male group, young female group and old group. Student t test was used for statistical difference between young groups and old group and less than 0.05 of p value was significant.

*Ethical considerations*

The protocol of this project was approved by the Institutional Review Board of Hinomine Medical Center (Komatsushima, Tokushima, Japan). The procedures were fully explained to subjects and an informed-consent form was signed.

## RESULTS

Baseline characteristics of young and old groups were presented in Table 1. BMI in old group was higher than those of young groups. Mean values of SMM (kg), its rate (%) of body weight and CHI (%) of young male and female groups were 34.7 kg and 22.3 kg, 53.4% and 43.7%, and 106.5% and 111.4%, respectively. Those of old subjects suffering from walking difficulty showed approximately 30-50%, 36-44% and 44-46% of young subjects, respectively (Table 1).

Putative intestinal absorption rates that were the rate of urinary excretion among total intake of nitrogen and sodium did not show any differences between those in old group and in young groups, in contrast, those of calcium and phosphorus in old group were significantly lower than those of young groups (Table 2).

## DISCUSSION

This study for the first time measured SMM, %SMM of body weight and CHI of old Japanese women suffering from walking difficulty in nursing homes and compared with young university students. Ninety-eight percent of body creatine is in skeletal muscle and a constant fraction of the body creatine pool is converted each day to creatinine (15). Hence, measurement of creatinine in 24 h urine collection should reflect total body creatinine and consequently total SMM (16). A linear relation was also found between anthropometrically derived lean body mass and 24-h creatinine excretion for men up to age 65. This relation attributed 21.8 kg of muscle mass for the excretion of 1 g creatinine in 24 h (12). However, it could be considered a limitation that we used 24 h creatinine excretion as measure of SMM instead of what is considered the gold standard (MRI or DXA). A specific limitation of using creatinine excretion as measure of SMM is that 24 h urine collections are prone to errors. We, however, thoroughly instructed participants and used two 24 h collections to increase accuracy, because both MRI and DXA are expensive and difficult to introduce in nursing home.

CHI is a valid and very simple another tool for assessment of protein status in patients with varieties of diseases including malnutrition. It has been reported that interpretation of CHI was as follows, If CHI ≥ 80%, there was normal protein status, if CHI 60-< 80%, there was mild protein depletion, if CHI 40-< 60%, there was moderate protein depletion and if CHI < 40%, there was severe protein depletion (17). It was thought that SMM values in this study were considerably correct and reliable because CHI in both young male and female groups represented approximately 100-110. Therefore, the results in this study indicated that moderate protein depletion observed in old women strongly suggested to be high risk for walking difficulty, fall, bone fracture and bedridden in nursing home.

The physiological ageing changes or degree of senescence experienced by each person's body system associated with ageing differs for each individual across the human lifespan. However, as a person ages, they are increasingly at risk of injury, illness and death. In geriatric assessment an older person is considered to be frail when they have three or more of the following : unintentional weight loss, weakness defined by grip strength, low physical activity and slowed motor performance (18). The loss of SM is a common problem in older adults from around the world that reaches a prevalence ranging from 7% to over 50% (19). As a result of frailty the older person is more at risk of adverse health outcomes that can result in hospitalization, frequently as a result of falls and disability, and nursing home placement and mortality (20). It has been suggested that the maintaining muscle mass in old age is a key factor

Table 1

| | Young | | Old | p-value |
|---|---|---|---|---|
| Age(y : range(Mean±SD)) | 21-24(21.9± 1.2)†‡ | | 82-93(87.3± 4.3)†‡ | 0.009 |
| Sex(n) | Male(7) | Female(6) | Female(4) | |
| Height(cm) | 173.1± 4.8*† | 158.5± 6.7*‡ | 143.3± 7.1†‡ | 0.002 |
| Body weight(kg) | 65.4± 7.3* | 51.0± 3.4* | 55.8± 7.1 | 0.011 |
| BMI(kg/m$^2$) | 21.8± 1.9† | 20.4± 1.7‡ | 27.1± 0.9†‡ | 0.009 |
| Energy intake(kcal/kg/d) | 32.8± 5.9 | 38.7± 8.7‡ | 24.5± 2.9‡ | 0.018 |
| Protein intake(g/kg/d) | 1.2± 0.2† | 1.4± 0.4‡ | 0.8± 0.1†‡ | 0.008 |
| Skeletal mascle mass(kg) | 34.7± 2.8*† | 22.3± 1.4*‡ | 10.6± 0.9†‡ | 0.001 |
| Skeletal mascle mass(% of kg) | 53.4± 4.2*† | 43.7± 1.4*‡ | 19.2± 2.6†‡ | 0.001 |
| Creatinine height index(%) | 106.5± 8.3† | 111.4± 3.6‡ | 48.9± 6.7†‡ | 0.007 |

* : p< 0.05 (Young-Male vs Young-Female) by Steel-Dwass test
† : p< 0.05 (Young-Male vs Old) by Steel-Dwass test
‡ : p< 0.05 (Young-Female vs Old) by Steel-Dwass test
p-value (Young-Male vs Young-Female vs Old) by kruskal-wallis test

Table 2

| | Young | | Old | p-value |
|---|---|---|---|---|
| Sex(n) | Male(6) | Female(7) | Female(4) | |
| N-intake(g/d) | 12.1± 1.8 | 11.8± 2.9 | 6.9± 1.2 | 0.956 |
| N-excretion(g/d) | 10.7± 1.7*† | 7.9± 1.2*‡ | 4.3± 0.5†‡ | 0.027 |
| N-balance(g/d) | 1.4± 2.4 | 3.9± 2.9 | 2.7± 0.8 | 0.401 |
| N-absorption rate(%) | 93.0± 20.3† | 75.2± 20.4 | 62.8± 5.1† | 0.258 |
| Na-intake(mg/d) | 2611± 497.6 | 2612± 494.0 | 2388.5± 126.9 | 1.000 |
| Na-excretion(mg/d) | 3957.0± 897.6† | 3016.5± 819.3 | 2287.5± 327.6† | 0.200 |
| Na-balance(g/d) | -1345.3± 1101.2 | -404.8± 1025.1 | 101.0± 371.6 | 0.488 |
| Na-absorption rate(%) | 159.1± 51.7 | 119.9± 43.1 | 97.0± 15.3 | 0.326 |
| Ca-intake(mg/d) | 644.1± 122.9 | 644.5± 122.0 | 538.9± 31.9 | 1.000 |
| Ca-excretion(mg/d) | 95.7± 30.2 | 131.1± 41.6‡ | 52.5± 17.1‡ | 0.258 |
| Ca-balance(g/d) | 548.6± 122.9 | 513.4± 127.9 | 486.4± 27.0 | 0.975 |
| Ca-absorption rate(%) | 15.0± 5.2 | 21.0± 8.4‡ | 9.6± 3.0‡ | 0.258 |
| P-intake(mg/d) | 1076.6± 205.2 | 1122.9± 212.4‡ | 808.3± 47.0‡ | 1.000 |
| P-excretion(mg/d) | 730.0± 140.3*† | 540.6± 94.1*‡ | 256.3± 49.7†‡ | 0.040 |
| P-balance(g/d) | 346.6± 231.0 | 582.4± 238.4 | 552.0± 7.9 | 0.258 |
| P-absorption rate(%) | 71.3± 17.3† | 53.5± 15.0‡ | 31.6± 4.6†‡ | 0.151 |

* : p< 0.05 (Young-Male vs Young-Female) by Steel-Dwass test
† : p< 0.05 (Young-Male vs Old) by Steel-Dwass test
‡ : p< 0.05 (Young-Female vs Old) by Steel-Dwass test
p-value (Young-Male vs Young-Female vs Old) by kruskal-wallis test

for conserving physical capacity and enabling independent lifestyles in old age. Therefore, the human economic and societal impact from decreased SMM is enormous rehabilitation programs have been considered to be the best option for maintaining and restoring functional ability in older people following a fall or disability.

Several factors are involved in the maintenance of activities of daily living (ADL) in older adults. Skeletal muscle mass and strength are important factors for maintaining independence and quality of life in elderly. The values of SMM (10.6 kg), %SMM (43.7%) and CHI (48.9%) might be the cutting edge of bedridden in old Japanese women although further study particularly in old man should be required. The present study also suggests that among participants living in nursing homes, decreased intestinal calcium and phosphorus absorption is associated with SMM loss and walking difficulty. The scope of gerontological nursing involves using comprehensive geriatric evaluation to fully understand the needs of the older person. Therefore, it should be emphasized from this study that SMM, %SMM of body weight and CHI values are important and useful biomarker to design and provide rehabilitation program for the maintaining and restoring SMM in each individual.

## CONFLICT OF INTEREST

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