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Original Study

Low Serum Selenium Level Is Associated With Low Muscle Mass in the Community-Dwelling Elderly

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A B S T R A C T

Objectives: Elderly persons with low muscle mass (LMM) or sarcopenia are prone to frailty and functional decline. This study aimed to investigate the relationship between serum selenium level and skeletal muscle mass in community-dwelling elderly.
Design: Cross-sectional observational study.
Setting and participants: A total of 327 elderly Taipei citizens (mean age 71.5 ± 4.7 years) were recruited from the community.
Measurements: Skeletal muscle mass was measured by bioelectrical impedance analysis. LMM was defined by low skeletal muscle index (SMI: muscle mass (kg)/[height (m)]^2). All participants were further divided into quartiles by serum selenium level and the risk for LMM among these quartiles was examined using multivariate logistic regression analyses. Estimated serum selenium levels for the LMM group vs the normal group and estimated SMI in the quartiles of serum selenium were computed by least square method in linear regression models.
Results: The estimated mean (±standard deviation) of serum selenium level was significantly lower in the LMM group compared with the normal group after adjusting for confounders (1.01 ± 0.03 μmol/L vs 1.14 ± 0.02 μmol/L, $P < .001$). After adjusting for age, sex, lifestyle, and physical and metabolic factors, the odds ratios (95% confidence interval, P value) of LMM in the bottom, second, and third selenium quartile groups were 4.62 (95% CI 2.11–10.10, $P < .001$), 2.30 (95% CI 1.05–5.03, $P < .05$) and 1.51 (95% CI 0.66–3.46, $P = .327$), respectively, compared with the top quartile group of serum selenium level. The least square mean of SMI increased with the quartiles of serum selenium ($P < .001$).
Conclusions: This is the first study to demonstrate that low serum selenium is independently associated with low muscle mass in the elderly. The causality and underlying mechanism between selenium and low muscle mass or sarcopenia warrant further research.

Sarcopenia is the gradual loss of muscle mass and strength with aging. Geriatric patients with sarcopenia usually suffer from frailty and disability.[1] Previous studies have reported several risk factors for sarcopenia, including genetic factors, nutrition, exercise, neuromuscular dysfunction, hormone reactivity, or inflammation.[2] In addition, oxidative injuries during aging play a crucial role in muscle loss.[3,4] It has been proposed that taking recommended dietary allowances of antioxidants may protect people from abnormal reductions of skeletal muscle mass.[5]

Selenium is one of the most important antioxidants in humans. The distribution and function of selenoenzymes such as cytosolic glutathione peroxidase and selenoprotein P modulate protection against oxidative damage, and mutations in selenoprotein genes can lead to muscular diseases.[6,7] In lambs, selenium deficiency is also associated with white muscle disease characterized by weakness and calcification in skeletal muscles and myocardium.[8] One study investigating the association between selenium and muscle function showed an

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improvement in muscle strength after selenium supplementation in a patient with long-term parenteral nutrition,[9] whereas another study reported no difference between normal persons and those with decreased muscle mass with regard to dietary selenium intake.[5] The Invecchiare in Chianti (InCHIANTI) study enrolled randomly selected Italian persons older than 65 years and tested the association between serum selenium level and handgrip, hip flexion, and knee extension muscle strength of the persons.[10] Beck et al[11] also examined the association of serum selenium level and handgrip strength in elderly female persons. Both studies concluded that a low selenium level was associated with reduced muscle strength.[10,11] Despite the attempt to elucidate the role of selenium in muscle function, these studies focused on muscle strength measures instead of direct evaluation of muscle mass.

Whether or not selenium influences the maintenance of muscle mass, which provides clinicians with a greater insight into the pathogenic mechanism of sarcopenia, remains unclear. Therefore, we conducted this cross-sectional community study to investigate the relationship of serum selenium and skeletal muscle mass in the community-dwelling elderly.

Methods

Participants

A total of 327 volunteers living in Taipei were recruited in 2007 by advertisements. The inclusion criteria were individuals aged 65 years or older and could stand steadily on the bioelectrical impedance analysis (BIA) system during measurements of bioelectrical impedance. Participants with cancer history, recent body weight change more than 5% in 3 months, and those implanted with cardiac pacemakers or metal implants were excluded. All participants provided written informed consent, and all protocols were approved by the Ethics Committee of the National Taiwan University Hospital.

Data on age, sex, history of hypertension, diabetes mellitus, cardiovascular diseases, cigarette smoking, exercise habits, nutritional status, and functional status were obtained by individual interviews. Current and noncurrent smokers were defined according to their recent smoking habit.[12] Exercise status was defined as whether the subject had exercise habit at least once a week. The nutritional status of the participants was evaluated by mini-nutritional assessment (MNA).[13,14] Functional status was evaluated by Barthel index and Lawton-Brody instrumental activities of daily living scale.[15,16] Height and weight were measured to obtain body mass index (BMI).[12] Waist circumferences, and systolic and diastolic blood pressure were recorded for evaluating status of metabolic syndrome (MetS). Disease histories such as diabetes mellitus, hypertension, and hyperlipidemia were evaluated, and current prescriptions including antihypertensive, antihyperglycemic, or antihyperlipidemia agents were recorded based on self-reported history. MetS was diagnosed according to the America Heart Association and National Heart Lung and Blood Institute criteria modified for Taiwan population.[17]

Skeletal Muscle Mass Estimation and Low Muscle Mass Definition

Skeletal muscle mass was estimated by bioelectrical impedance analysis.[18] Skeletal muscle mass index (SMI) was calculated by dividing the skeletal muscle mass with the square of body height (kg/m^2). Low muscle mass (LMM) was defined as a SMI value 2 standard deviations (SDs) below the mean, which has been reported to be less than 8.87 kg/m^2 in males or 6.42 kg/m^2 in females in Taiwan.[19] There were 97 persons classified in the LMM group (31 males and 66 females) and 230 persons classified in the normal group (73 males and 157 females).

Measurement of Serum Selenium Level and Other Biomarkers

Venous blood samples were taken after fasting for at least 8 hours. Serum glucose, total cholesterol, high-density lipoprotein cholesterol, low-density lipoprotein cholesterol (LDL-C), and triglycerides were assessed by automatic spectrophotometric assay. Selenium was measured using inductively coupled plasma mass spectroscopy.[12]

Statistical Analysis

Statistical analyses were performed using SPSS v17.0 (SPSS Inc., Chicago, IL). A P value of less than .05 was considered to be statistically significant. The participants were divided into quartiles according to serum selenium level. Analysis of variance was used for continuous variables and the χ^2 test for categorical variables to analyze interquartile differences. The risk of LMM by selenium levels was analyzed using multivariate binary logistic regression models. Age, sex, and BMI were adjusted in model 1. Exercise, smoking, and MNA score were further adjusted in model 2. MetS, LDL-C, and uric acid level were added in model 3.

To further explore the relationship between the serum selenium and SMI, the serum selenium levels of LMM and normal group were estimated by least square (LS) method in a multivariate linear regression model after adjusting confounding factors based on model 3 except sex. The SMI across serum selenium quartiles was also estimated by LS method in multivariate linear regression model after adjusting confounding factors in model 3.

Results

The demographics, personal history, and laboratory findings of the participants by serum selenium quartiles are shown in Table 1. The participant Barthel index was 100 and instrumental activities of daily living scale score was 7.81 ± 0.51 (maximum is 8 points). The mean SMI values in the LMM group were 8.11 ± 0.59 kg/m^2 in males and 5.80 ± 0.42 kg/m^2 in females. The mean SMI values in the normal group were 10.12 ± 0.82 kg/m^2 in males and 7.81 ± 0.93 kg/m^2 in females. The percentages of LMM were 29.7% in all participants, 29.8% in men, and 29.6% in females, respectively.

The mean selenium level was 1.10 ± 0.25 μmol/L, and the interquartile cut-off values of selenium were 0.90, 1.08, and 1.29 μmol/L. There were no interquartile differences in lifestyle, functional status, and most metabolic or anthropometric measurements, however, there were significant differences in female BMI ($P = .016$), serum LDL cholesterol level ($P = .005$), and uric acid level ($P = .015$).

The SMI values increased with increasing quartile of serum selenium concentration ($P = .022$), and the percentage of LMM decreased significantly across the quartiles of serum selenium ($P = .001$). After adjustments for lifestyle, metabolic and anthropometric confounding factors, the LS mean (±SD) of serum selenium level in the LMM group was significantly lower than in the normal group (1.01 ± 0.03 μmol/L vs 1.14 ± 0.02 μmol/L, respectively, $P < .001$, Figure 1).

Table 2 showed the association of serum selenium and LMM by multivariate logistic regression analyses in models 1–3. The results showed that a lower selenium level was correlated with a higher risk of LMM after adjusting for confounding factors (P for trend were <.001, .001, and .001 in models 1–3; R^2 were 0.530, 0.534 and 0.591 in models 1–3, respectively). The odds ratios of risk for LMM in the bottom, second, and third selenium quartile groups were 4.62 (95% CI 2.12–10.1, $P < .001$), 2.30 (95% CI 1.05–5.03, $P < .05$) and 1.51 (95% CI 0.66–3.46, $P = .327$), respectively, compared with the top quartile in model 3. Figure 2 shows that the LS means (±SDs) of the SMI increased with increasing serum selenium concentration in the linear multivariate regression models after adjusting for the confounding