Using nutritional assessment to predict gender-specific risks of sarcopenia among the elderly receiving health check-up in Taipei

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Quality of life for the elderly in an ageing society is receiving more attention than ever. After age 40, muscle mass loses at the rate of 3% to 8% every 10 years.[1] Moreover, the decline intensifies after 60 years old. Although many people do not experience changes in total body weight, their muscle mass is slowly replaced by body fat. Decreased muscle mass means lower muscle strength, which affects physical functioning. As a result, daily activities become constrained, risks of fall and bone fracture elevated, self-care ability and quality of life deteriorated, health expenditure increased, and even death ensued.[1–3] Therefore, early identification of high risk sarcopenic patients and halting or slowing down muscle loss are urgent health issues in old age.[4]

Baumgartner, et al.[5] developed diagnostic criteria for sarcopenia in 1998. In 2010, the European Working Group on Sarcopenia in Older People (EWGSOP) held that, in addition to low muscle mass, muscle strength and physical performance were important components to define sarcopenia.[6] A Taiwanese study showed that prevalence of sarcopenia in men was 18%–64% and in women 9%–41%.[7] An epidemiologic study in 2013 on sarcopenia in Taiwan indicated a prevalence rate of 5.3% in older men > 65 years who lived in Douliou and Gukeng, Yunlin County. In its study population, old age, male, lower body mass index (BMI) and higher body fat percentage were independent risk factors.[8]

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Recent research on sarcopenia focuses on early identification of high risk groups who suffer from malnutrition.[16] The study evaluated the association between sarcopenia and nutritional assessment scores obtained by the Short-Form Mini-Nutritional Assessment (MNA-SF) in order to provide evidence for future nutritional intervention.[16,17]

In March 2014, a cross-sectional survey was carried out among those who received elderly health check-ups in a regional hospital in Taipei. We used a purposeful sampling strategy, and enrolled 863 participants aged over 65, including 352 men and 511 women. This study has been approved by the Ethics Committee of Taipei City Hospital.
(TCHIRB-1020212-E), and informed consent was obtained from all participants.

All participants received structured questionnaire interviews enquiring their demographic information, drinking and smoking habits, past medical history, regular exerciser or not, ability to live independently, and MNA-SF. Blood samples were collected after they had fasted for 12 h to measure serum albumin levels. A regular exerciser was defined as an individual who engaged in physical activities for at least 150 min a week. Those who exercised below 150 min a week were considered non-regular exercisers. Individuals who could perform activities of daily living without assistance from others were defined as “having the ability to live independently.” Those who needed others’ assistance to perform activities of daily living were defined as “not having the ability to live independently.”

MNA, with excellent clinical sensitivity, specificity and predictive values of 96%, 98% and 97%, respectively, appeared to be a suitable nutritional assessment tool for the elderly. The study used MNA-SF to assess participants’ nutritional status. A MNA-SF score ≤ 11 suggested “risk of malnutrition”, while a score ≤ 10 suggested “risk for malnutrition”.

All of the recruited participants underwent body composition analysis using the same bio-impedance analysis (BIA) machine (BioSpace-INBODY-230, Korea). This BIA model with a constant high frequency current (100 kHz, 330 μA) and an eight-contact electrode was designed to measure the percentages of fat, bone, fluid and muscle of the trunk and each extremity. Research examining the relationship between BIA and DEXA, after controlling for age and gender, indicated a correlation coefficient of 0.974 (P < 0.001). The researchers used BIA method to measure appendicular skeletal muscle mass (ASM) that described the sum of muscle mass in four extremities. ASM (kg) was then divided by the average values were 6.082 ± 0.653 kg/m² for sarcopenic men and 0.871 ± 0.062 for non-sarcopenic men, 7.532 ± 0.592 kg/m² for non-sarcopenic women. The differences between sarcopenic and non-sarcopenic groups in both genders were statistically significant (P < 0.001). In men, 28 participants were at risk for malnutrition, with 19 (68%) of them being sarcopenic and 9 (32%) non-sarcopenic. There were 302 men with satisfactory nutritional status, 64 (21%) of whom being sarcopenic and 238 (79%) non-sarcopenic. In women, 61 were at risk for malnutrition, with 45 (73%) being sarcopenic and 16 (27%) non-sarcopenic. There were 428 women with satisfactory nutritional status, 82 (19%) of whom being sarcopenic and 346 (81%) non-sarcopenic.

In the aspects of medication, fluid intake, assisted eating, and self-perceived nutritional status, no significant differences were identified. But 12% of the sarcopenic men and 3.6% of the non-sarcopenic men reported “not having the ability to live independently” (P < 0.05). Among women, 6.3% of the sarcopenic group and 5.8% of the non-sarcopenic group reported “not having the ability to live independently” but the difference was not significant.

Regarding the appendicular skeletal muscle index (ASMI, kg/m²), the average values were 22.9 ± 2.7 kg/m² for sarcopenic men, 20.6 ± 2.4 kg/m² for non-sarcopenic men, 24.5 ± 2.7 kg/m² for sarcopenic women and 24.4 ± 3.4 kg/m² for non-sarcopenic women. The differences between two groups in both genders were statistically significant (P < 0.001).

Regarding BMI, the average values were 6.6 years (P < 0.001), respectively. Mean age for the female sarcopenic and non-sarcopenic groups was 76.2 ± 6.8 years and 72.3 ± 6.1 years, respectively (P < 0.001). No significant differences were found between regular exercisers, genders, and having sarcopenia or not.

In the nutrition assessment, 22.9% of the sarcopenic men and 3.6% of the non-sarcopenic men were at risk for malnutrition. In female participants, 35.4% of the sarcopenic group and 4.4% of the non-sarcopenic group were at risk for malnutrition. Differences between sarcopenic and non-sarcopenic groups in both genders were statistically significant (P < 0.001). In men, 28 participants were at risk for malnutrition, with 19 (68%) of them being sarcopenic and 9 (32%) non-sarcopenic. There were 302 men with satisfactory nutritional status, 64 (21%) of whom being sarcopenic and 238 (79%) non-sarcopenic. In women, 61 were at risk for malnutrition, with 45 (73%) being sarcopenic and 16 (27%) non-sarcopenic. There were 428 women with satisfactory nutritional status, 82 (19%) of whom being sarcopenic and 346 (81%) non-sarcopenic.

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Regarding the appendicular skeletal muscle index (ASMI, kg/m²), the average values were 6.082 ± 0.653 kg/m² for sarcopenic men, 7.532 ± 0.592 kg/m² for non-sarcopenic men, 4.869 ± 0.381 kg/m² for sarcopenic women and 6.123 ± 0.804 kg/m² for non-sarcopenic women. The differences between two groups in both genders were statistically significant (P < 0.001).

Regarding BMI, the average values were 22.9 ± 2.7 kg/m² for sarcopenic men, 20.6 ± 2.4 kg/m² for non-sarcopenic men, 24.5 ± 2.7 kg/m² for sarcopenic women and 24.4 ± 3.4 kg/m² for non-sarcopenic women. The differences between two groups in both genders were statistically significant (P < 0.001).

Regarding waist-hip ratio, the average values were 0.867 ± 0.0557 for sarcopenic men and 0.871 ± 0.062 for non-
Table 1. Characteristics of study subjects stratified by gender.

|                      | Men         |          | Women       |          | Total       |          |
|----------------------|-------------|----------|-------------|----------|------------|----------|
|                      | Sarcopenic  | Non-sarcopenic | P          | Sarcopenic | Non-sarcopenic | P          | Sarcopenic | Non-sarcopenic | P          |
| Age, yrs             | 78.5 ± 7.7  | 74.6 ± 6.6 | < 0.0001    | 76.2 ± 6.8 | 72.3 ± 6.1 | < 0.0001    | 77.2 ± 7.3 | 73.2 ± 6.4 | < 0.0001    | 0.3924     |
| Education            | 0.8411†     |          | 0.2445$    |          | 0.3742$    |          | 0.3742$    |
| Over highschool      | 70 (72.2%)  | 186 (73.2%) |          | 55 (42.0%) | 180 (47.9%) |          | 125 (54.8%) | 366 (58.1%) |          |
| Under highschool     | 27 (27.8%)  | 68 (26.8%) |          | 76 (58.0%) | 196 (52.1%) |          | 103 (45.2%) | 264 (41.9%) |          |
| Regular exerciser    | 0.2311†     |          | 0.9919$    |          | 0.4710$    |          | 0.0510$    |
| Yes                  | 89 (93.7%)  | 221 (89.5%) |          | 101 (79.5%) | 296 (79.6%) |          | 190 (85.6%) | 517 (83.5%) |          |
| No                   | 6 (6.3%)    | 26 (10.5%) |          | 26 (20.5%) | 76 (20.4%) |          | 32 (14.4%) | 102 (16.5%) |          |
| Having ability to live independently | 0.0107†   |          | 0.8372†    |          | 0.0510$    |          | 0.3474†    |
| Yes                  | 73 (88.0%)  | 240 (96.4%) |          | 120 (93.8%) | 344 (94.2%) |          | 193 (91.5%) | 584 (95.1%) |          |
| No                   | 10 (12.0%)  | 9 (3.6%)   |          | 8 (6.3%)   | 21 (5.8%)  |          | 18 (8.5%)  | 30 (4.9%)   |          |
| Taking more than 3 different prescription medications daily | 0.2075†    |          | 0.8448$    |          | 0.6486†    |          | 0.3474†    |
| Yes                  | 37 (44.6%)  | 92 (36.8%) |          | 44 (34.4%) | 122 (33.4%) |          | 81 (38.4%) | 214 (34.8%) |          |
| No                   | 46 (55.4%)  | 158 (63.2%) |          | 84 (65.6%) | 243 (66.6%) |          | 130 (61.6%) | 401 (65.2%) |          |
| Daily fluid intake   | 0.1412†     |          | 0.3922$    |          | 0.1121$    |          | 0.6486†    |
| < 5 cups*            | 23 (27.7%)  | 50 (20.0%) |          | 35 (27.3%) | 86 (23.6%) |          | 58 (27.5%) | 136 (22.1%) |          |
| > 5 cups             | 60 (72.3%)  | 200 (80.0%) |          | 93 (72.7%) | 279 (76.4%) |          | 153 (72.5%) | 479 (77.9%) |          |
| Assisted eating      | 0.2598$    |          | 1.0000†    |          | 0.6486†    |          | 0.1087$    |
| Yes                  | 2 (2.4%)    | 2 (0.8%)  |          | 0         | 2 (0.5%)   |          | 2 (0.9%)   | 4 (0.7%)    |          |
| No                   | 81 (97.6%)  | 248 (99.2%) |          | 128 (100%) | 363 (99.5%) |          | 209 (99.1%) | 611 (99.3%) |          |
| Self-perceived nutritional status | 1.0000†    |          | 0.556$     |          | 0.0001$    |          | 0.0001$    |
| Poor                 | 0           | 1 (0.4%)  |          | 3 (2.3%)  | 1 (0.3%)   |          | 3 (1.4%)   | 2 (0.3%)    |          |
| Good                 | 83 (100%)   | 249 (99.6%) |          | 125 (97.7%) | 364 (99.7%) |          | 208 (98.6%) | 613 (99.7%) |          |
| Mini-MNA             | < 0.0001†   |          | < 0.0001†  |          | 0.0001†    |          | 0.0001†    |
| At risk for malnutrition | 19 (22.9%) | 9 (3.6%)  |          | 45 (35.4%) | 16 (4.4%)  |          | 64 (30.5%) | 25 (4.1%)  |          |
| Satisfactory         | 64 (77.1%)  | 238 (96.4%) |          | 82 (64.6%) | 346 (95.6%) |          | 146 (69.5%) | 584 (95.9%) |          |
| 1ASM1, kg/m²         | 6.082 ± 0.653 | 7.532 ± 0.592 | < 0.0001 | 4.869 ± 0.381 | 6.123 ± 0.804 | < 0.0001 | 5.381 ± 0.789 | 6.689 ± 1.003 | < 0.0001 | 5.381 ± 0.789 | 6.689 ± 1.003 | < 0.0001 |
| 1BMI, kg/m²          | 22.1 ± 2.7  | 24.5 ± 2.7 | < 0.0001    | 20.6 ± 2.4 | 24.4 ± 3.4 | < 0.0001    | 21.2 ± 2.6 | 24.4 ± 3.1 | < 0.0001    | 0.0001†    |
| 1Waist-hip ratio     | 0.867 ± 0.055 | 0.871 ± 0.062 | 0.4049 | 0.839 ± 0.052 | 0.874 ± 0.059 | < 0.0001 | 0.851 ± 0.055 | 0.873 ± 0.06 | < 0.0001 | 0.851 ± 0.055 | 0.873 ± 0.06 | < 0.0001 |
| 1Body fat percentage | 28.0% ± 7%  | 25.2% ± 6.49% | 0.0002 | 32.1% ± 7.3% | 34.3% ± 6.58% | 0.0042 | 30.39% ± 7.46% | 30.65% ± 7.91% | 0.6604 | 30.39% ± 7.46% | 30.65% ± 7.91% | 0.6604 |
| 1Serum albumin       | 4.39 ± 0.25 | 4.45 ± 0.23 | 0.0266 | 4.34 ± 0.55 | 4.41 ± 0.46 | 0.3572 | 4.36 ± 0.45 | 4.42 ± 0.38 | 0.0315 | 4.36 ± 0.45 | 4.42 ± 0.38 | 0.0315 |

Data are presented as mean ± SD or n (%) unless other indicated. *1 cup is equal to about 240 mL; †Wilcoxon rank sum test; §Chi-square test; ¶Fisher’s exact test. ASM: appendicular skeletal muscle index; sarcopenia: men ASM < 6.76 kg/m², women ASM < 5.28 kg/m²; body fat percentage: total body fat/weight; BMI: weight/height; Mini-MNA: satisfactory vs. at risk for malnutrition.

Sarcopenic men. Their difference was not statistically significant. In women, the ratios were 0.839 ± 0.052 for the sarcopenic group and 0.874 ± 0.059 for the non-sarcopenic group. The difference was statistically significant (P < 0.001).

Regarding body fat percentage (%), the average values were 28.0% ± 7.0% for sarcopenic men, 25.2% ± 6.5% for non-sarcopenic men, 32.1% ± 7.3% for sarcopenic women and 34.3% ± 6.6% for non-sarcopenic women. The differences between two groups in both genders were statistically significant (P < 0.001).
Regarding serum albumin level, the average values were 4.39 ± 0.25 mg/dL for sarcopenic men and 4.45 ± 0.23 mg/dL for non-sarcopenic men. The difference was significant ($P < 0.05$). The values for sarcopenic and non-sarcopenic women were 4.34 ± 0.55 mg/dL and 4.41 ± 0.46 mg/dL, and not significantly different.

Table 2 shows adjusted odds ratios for sarcopenia. After controlling for confounders, age demonstrated as a significant factor (OR = 1.11, $P < 0.001$). The ability to live independently and serum albumin level had OR of 1.01 and 0.93, but neither was statistically significant.

After adjusting for gender, ability to live independently and serum albumin level, the risk of sarcopenia among the elderly increased by 11% for every additional 0.1 year. This segment of population might face a quick transition from a non-sarcopenic to sarcopenic state. The mean age range of sarcopenic subjects was between 76 and 78 years, indicating the importance of lifestyle and dietary modification in preventing sarcopenia and improving quality of life for those above 70 years.

Individuals with MNA-SF scores ≤ 11 were considered to be at risk for malnutrition. The current survey observed one out of 4–5 men and 1 out of 3 women to be sarcopenic. However, the participants were not aware of their risk despite such a high incidence. It suggests that although high-risk elderly received routine health check-ups, nutritional risks remained unidentified. MNA-SF could play a role for community-based non-medical workers to identify mal-nourished high-risk individuals. It could also enable the elderly at risk of sarcopenia and their families to start early intervention by making dietary and lifestyle changes.

The mean BMI for the sarcopenic elderly was 21.2 ± 2.4 kg/m², falling within the 18.5–24 normal range. A Taiwan research on elderly health pointed out a 40% rise in mortality when BMI was below 23.6 kg/m². In both genders, the sarcopenic subjects had significantly lower BMI values than their non-sarcopenic counterparts. In particular, older sarcopenic women had smaller waist and hips, suggesting a higher likelihood of sarcopenia among elderly women with lower body weight. On the other hand, sarcopenic men had higher body fat percentage. Future studies are suggested to examine the distribution of body fat, walking ability and abdominal obesity in older men. Furthermore, epidemiologic surveys are needed to determine a healthy BMI range for the population above 65 years. Efforts to retain lean muscle mass by consuming sufficient protein-containing food and receiving strength training are warranted for the elderly who engage in weight loss programs.

Past literature indicated that serum albumin concentration was associated with muscle strength, muscle function, mobility and balance. Another research examining men aged 35–57 years found a significantly negative association between serum albumin level and coronary artery disease (CAD). When the serum albumin concentration was over 47 g/L, the OR for having CAD was only 0.45 and OR for dying from the same disease was 0.29. It concluded that serum albumin level < 4.4 mg/dL in men was a protector against CAD. In the present study, the serum level in women’s sarcopenic group was lower than that in the non-sarcopenic group but the difference was not significant. The serum level was relatively low among sarcopenic men. In both genders, the sarcopenic groups had serum levels < 4.4 mg/dL. Further investigation might pay attention to the relationship between sarcopenic patients and CAD.

The Elderly Nutrition and Health Survey in Taiwan (1990–2000) found that average energy intake of those older than 65 years was 1833 kcal in men and 1477 kcal in women. Dietary protein intake was 76 g in men and 61 g in women. The main sources of protein for men included fish, meat and eggs, while for women dairy and soya products constituted their sources of protein. According to the seventh edition of Taiwan’s dietary reference intake and daily dietary guidance, the energy intake level of the elderly participants in the current study fell in the category of low-intensity physical activity and body weight between 50 and 60 kg. Protein intake level went far beyond the recommended 50–60 g, but the dairy consumption was below the recommended amount of 1.5 portions. Different characteristics of populations in different studies, such as location of residence or cohort effects, might explain the difference in dietary protein intake. Literature on the association between food consumption and maintenance of lean muscle

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**Table 2. Multivariable regression models of sarcopenia.**

|                          | Odds ratio (95% CI) | B† | SE† | P† |
|--------------------------|--------------------|-----|-----|----|
|                          | Unadjusted         | Adjusted                 |     |     |
| Age                      | 1.09 (1.06–1.11)   | 1.11 (1.08–1.14)         | 0.10 | 0.01 | < 0.0001 |
| Having the ability to live independently | 1.82 (0.99–3.33) | 1.01 (0.50–2.05)         | 0.01 | 0.36 | 0.9747 |
| Serum albumin level      | 0.71 (0.50–1.03)   | 0.93 (0.63–1.36)         | –0.07 | 0.20 | 0.7047 |
| Mini-MNA                 | 0.10 (0.06–0.16)   | 0.08 (0.05–0.14)         | –2.49 | 0.27 | < 0.0001 |

*Controlled for ability to live independently, serum albumin level. Mini-MNA: satisfactory vs. at risk for malnutrition.
mass pointed out a decline in protein absorption in the older people. Therefore, policy makers determining nutritional recommendations for protein intake must take into account of the high prevalence of sarcopenia in old age and also introduce alternatives that address the problem of insufficient dairy (calcium) intake.

The findings suggested that the elderly aged over 70 years and with BMI lower than 20–22 kg/m² pay attention to sarcopenia prevention. As the elderly men often have poor health literacy and limited ability to live independently, the authors propose several strategies. The first is to take advantage of MNA-SF to do high-risk group screening. The second is building care-givers’ awareness and capacity about sarcopenia prevention. For example, care givers are advised to prepare high quality and low fat protein-rich dairy and soya food, fish, eggs, meat, etc. instead of fat-rich items such as milkfish belly portion, fatty meat or pork meat balls. In addition, elderly people of both genders require daily 1.5 portions of low-fat dairy intake which supplies protein as well as calcium.

The authors acknowledge several limitations. First, due to a low percentage of subjects at risk for malnutrition, we failed to analyze the within-group differences. Second, the relationship between dietary protein intake, muscle strength in the extremities, and body fat distribution was not discussed because we lacked diet details. Sarcopenic elderly’s nutrition and exercise recommendation appeared to be worthy of future investigation in relation to an effective eating questionnaire, muscle strength and body fat distribution.

Early identification of individuals at risk for malnutrition was the main concern of the research. Adoption of Mini-Nutritional Assessment SF appeared to be a suitable approach and worth promotion. The research shows that the elderly people above 70 and with BMI below 20–22 might face a quick transition from a non-sarcopenic to sarcopenic state. Thus, using MNA-SF helps identify people at high risk for sarcopenia and highlights the need to make dietary and lifestyle changes as a means to improve the elderly’s quality of life.

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