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# Predicting sarcopenia in community-dwelling older adults through comprehensive physical fitness tests

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## Abstract

**Background** Sarcopenia is typically assessed through hand grip strength, walking speed, and chair stand tests. However, it has been inadequately examined in terms of other physical fitness (PF) components in community-dwelling older adults. Thus, in this study, we explored factors influencing the risk of sarcopenia in community-dwelling older adults. In addition, we analyzed the clinicodemographic characteristics of older adults with or without sarcopenia and investigated the effect of sex on their PF.

**Methods** This cross-sectional study included 745 older adults from a community health promotion program in Taiwan. Their clinicodemographic characteristics were recorded. PF was assessed through various tests, such as hand grip strength evaluation, 8-foot up-and-go test (8-UGT), 2-min step test, and 6-m walk test. PF and factors influencing sarcopenia risk were compared between older adults with sarcopenia (sarcopenia group) and those without it (non-sarcopenia group). A logistic regression model was performed to identify key factors associated with sarcopenia. Its predictive performance was evaluated by calculating the area under the receiver operating characteristic curve (ROC) curve.

**Results** Regardless of sex, the sarcopenia group performed worse in almost all components of PF—for example, upper and lower limb muscular strength and endurance, cardiopulmonary fitness, and balance—than did the non-sarcopenia group. However, for men, no significant between-group difference was observed in flexibility. The logistic regression model indicated age (odds ratio [OR]: 1.107), sex (OR: 2.881), Mini Nutritional Assessment—Short Form scores (OR: 0.690), and performance in 8-UGT (OR: 1.346) as factors influencing the risk of sarcopenia. The model exhibited excellent discriminative ability in predicting sarcopenia, as indicated by an area under the curve value of 0.867 (95% confidence interval: 0.827–0.906; $p < 0.05$).

**Conclusion** Older adults without sarcopenia tend to outperform those with sarcopenia in almost all PF measures, regardless of sex. Older age, male sex, low Mini Nutritional Assessment—Short Form scores, and poor performance in 8-UGT are associated with a high risk of sarcopenia.

**Keywords** Physical fitness, Sarcopenia, Older adults, 8-foot up-and-go test

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## Introduction

Sarcopenia is a condition characterized by reduced muscle mass and function [1]. Because its prevalence increases with population aging, sarcopenia has become a major public health concern among community-dwelling older adults [2]. The clinical presentation of sarcopenia varies; nonetheless, sarcopenia often leads to limitations in daily activities and increased risks of multimorbidity and mortality [3]. Physical inactivity and insufficient protein intake are the primary causes of sarcopenia [4]. However, other factors also contribute to the development of sarcopenia [3–6].

Despite the availability of numerous methods for screening, assessing, and monitoring sarcopenia, their systematic application has been limited because of demographic differences in body composition and physical performance as well as variations in study contexts [7]. Thus, the prevalence of sarcopenia is often underestimated [3]. Rikli and Jones developed a test battery for assessing functional fitness in community-dwelling older adults; this battery comprises multiple simple but effective tests that evaluate muscle strength, flexibility, aerobic endurance, agility, and dynamic balance by assessing daily activities [8]. Appropriate physical fitness (PF) tests can be used to objectively evaluate physical function in older adults participating in community activities to maintain or promote health [9]. PF tests are accessible, time-efficient, and convenient (require no specialized equipment), all of which contribute to their clinical practicality [10]. As part of the standard diagnostic battery for sarcopenia, body composition analysis, hand grip strength (HGS) evaluation, 6-m walk test (6MWT), and 5-time chair stand test (CST) are routinely performed in older adults. However, other functional fitness tests have rarely been used in Taiwanese older adults with sarcopenia. Furthermore, few sex-based subgroup analyses have been conducted in this context.

In line with Taiwan's National Ten-Year Long-Term Care Plan 2.0 (launched in 2015), a community-based health promotion program has been implemented in the country to prevent and delay disability in community-dwelling older adults. The effects of this program on seniors participating in community activities, such as exercise and dance classes at long-term care facilities, must be investigated to evaluate the program's efficacy. Lifestyle interventions, particularly exercise and nutritional supplementation, are key components of sarcopenia therapy [1]. To personalize sarcopenia management programs for older adults on the basis of their PF levels, all aspects of PF must be analyzed. By identifying specific areas where the PF of an older adult with sarcopenia is lacking, health-care professionals in preventive medicine and rehabilitation can design interventions to strengthen these areas, enabling the patient to effectively perform daily activities.

The present study differs from previous cross-sectional studies in two key respects. First, our study incorporated a relatively broad range of PF measures, such as aerobic capacity, balance, flexibility, and muscular endurance, in addition to traditional muscle mass and strength assessments. Tests such as the 8-foot up-and-go test (8-UGT), 30-s CST, and 2-min step test (2MST) facilitate comprehensive evaluation. Second, this study focused on community-dwelling older adults participating in a health promotion program, offering insights into the potential of such programs to prevent or delay sarcopenia. The objectives of the present cross-sectional study were to (1) explore the clinicodemographic characteristics of older adults with or without sarcopenia who participated in the aforementioned program, (2) analyze the effect of sex on the PF of these individuals, and (3) identify key factors (demographics, nutrition, and PF parameters) influencing the risk of sarcopenia in community-dwelling older adults.

## Methods

### Study design and cohort

This cross-sectional study included community-dwelling older adults who participated in a community health promotion program conducted by the Center of Community Medicine at National Yang Ming Chiao Tung University Hospital, Taiwan, between July 10, 2017, and December 25, 2019. All study procedures adhered to the ethical principles of the Declaration of Helsinki and those of National Yang Ming Chiao Tung University Hospital. This study was approved by the Human Subject Research Ethics Committee of National Yang Ming Chiao Tung University Hospital (approval number: 2020A012).

Eligible older adults were recruited through voluntary registration at community centers. Health-care professionals systematically assessed the participants to determine eligibility. Before the PF tests, the participants were provided with comprehensive information on the tests, such as their purpose, potential risks, and benefits. Informed consent was obtained from all participants. A preliminary screening was performed to identify individuals who met the basic criteria for participation. The participants' overall physical health was assessed through medical history-taking, physical examinations, and laboratory tests; this assessment was performed to confirm their ability to undergo the planned PF tests. Cognitive function was assessed by clinical physicians (N-WH, S-HY, and P-JP) during data collection. Only older adults who could answer questions, comprehend test instructions, and cooperate during the PF tests were included in

this study. No separate cognitive function data were collected or analyzed.

The inclusion criteria were as follows: (1) being aged ≥ 65 years and residing in Yilan County, (2) being interested in undergoing the PF tests, and (3) being able to perform study-related tasks. Before the tests, a physical therapist provided the participants with relevant instructions and made them practice the tests once or twice to ensure appropriate performance. Older adults with severe neurological or cognitive impairments, a recent history of traumatic events, acute illnesses that could compromise safety during the tests (e.g., unstable arrhythmia, sepsis, and unstable vital signs), and total dependence on caregivers for daily activities were excluded from the health promotion program. The aforementioned exclusion criteria were applied to ensure that the participants are safe during the tests and they complete all tests. These criteria were applied also in our previous studies [11–13], where we noted no complications during or after the tests. Furthermore, older adults whose skeletal muscle index data (obtained through bioimpedance examination) were incomplete were excluded from this study because the skeletal muscle index is a crucial measure for assessing body composition. Figure 1 depicts the process of participant selection.

### Data collection

Eligible older adults were invited to our health promotion center at National Yang Ming Chiao Tung University Hospital. Data were collected during the following five steps.

First, clinicodemographic data were collected from the participants. For further details, please refer to Supplementary Material 1. Second, a frailty questionnaire was administered. Physical activity (PA) levels were measured using a modified version of the International Physical Activity Questionnaire—Short Form [14].

Third, sarcopenia was assessed on the basis of the skeletal muscle index, HGS, and speed in 6MWT [1].

Fourth, comprehensive PF tests were conducted to evaluate the participants' body composition (body mass index), muscular strength and endurance (30-s arm curl [ACT] and 30-s CST) [8], flexibility (back scratch test [BST] and chair sit-and-reach test [CSRT]) [8], aerobic fitness (2MST) [8], and balance (8-UGT and single-leg stance test [SLST]) [8]. These assessments were

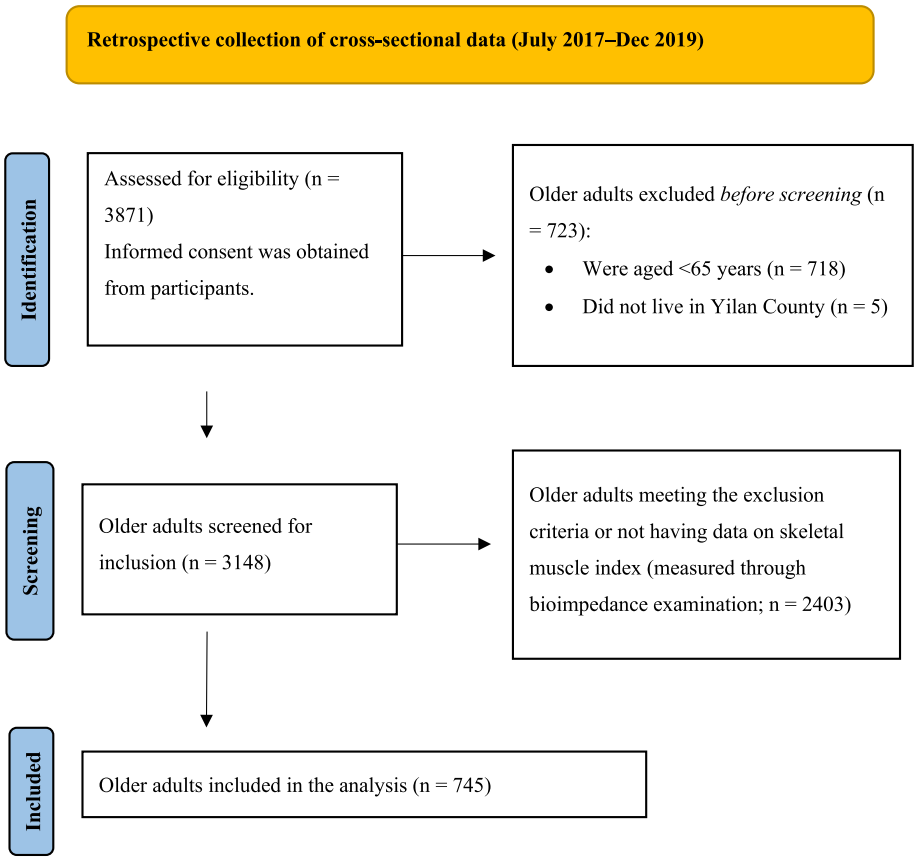


**Fig. 1** Flowchart depicting participant selection

performed following the guidelines put forth by the Sports Department of Taiwan's Ministry of Education.

Finally, the Mini Nutritional Assessment—Short Form (MNA-SF) was administered. This tool has been validated for assessing nutritional problems [15].

On the basis of a sarcopenia diagnosis, the participants were divided into sarcopenia and nonsarcopenia groups. Subsequently, the two groups were compared in terms of PF.

### Outcome measures

#### *Clinicodemographic characteristics*

Health-care professionals administered questionnaires and conducted interviews to obtain data on the participants' age, sex, PA levels, and medical history that could affect their ability to perform the tests.

#### *PA level*

The frailty questionnaire was used to collect data regarding the participants' HGS, energy level, walking speed, PA level, and unintentional weight loss [14]. Their PA levels were determined through interviews, during which data on calorie consumption were collected using the modified short version of the International Physical Activity Questionnaire—Short Form (Taiwan version) [14].

#### *Sarcopenia*

Sarcopenia was diagnosed on the basis of the Asian Working Group for Sarcopenia (AWGS) 2019 criteria [1]. Muscle mass was assessed by measuring bioimpedance (InBody 570; InBody); cutoff values of 7.0 and 5.7 kg/m$^2$ indicated low muscle mass in men and women, respectively. Low muscle strength was defined as an HGS of < 28 kg in men and < 18 kg in women. Low physical performance was defined as a speed of < 1.0 m/s in 6MWT.

#### *MNA-SF score*

Nutritional screening was performed by a qualified nutritionist (Y-TC). The MNA-SF was used for this purpose. This tool comprises six items. The total score on the MNA-SF ranges from 0 to 14. Total scores of 0–7, 8–11, and 12–14 indicate malnutrition, malnutrition risks, normal nutrition levels, respectively [15].

#### *PF level*

A qualified physical therapist and a PF coach collaborated with trained hospital volunteers to collect data on PF. Before the health promotion program, training sessions were conducted to ensure that the researchers could effectively conduct all tests. To enhance test speed and precision, a sensor-assistive system (Acutek) was used for evaluating geriatric PF levels; this method has been successfully used in other studies [11, 12]. The following tests were conducted: 30-s ACT, BST (a negative score indicated that the fingertips did not overlap), 30-s CST, CSRT (a negative score indicated that the fingertips did not pass the 0 mark), SLST, 8-UGT, 2MST, 6MWT, and HGS (TTM Digital Hand Grip Dynamometer; TTM110D). HGS was measured twice for each participant, and the higher of the two measured values was recorded.

### Statistical analysis

Statistical analyses were performed using SPSS (version 26.0; IBM Corporation, Armonk, NY, USA). Continuous variables, such as age, skeletal muscle index, HGS, 6MWT, and MNA-SF scores, were analyzed using an independent *t*-test. Categorical variables, such as sex and PA level, were analyzed using the chi-square test. For older adults with hypertension, diabetes, or hyperlipidemia and those engaging in PA > 3 times a week, the z-test was performed for between-group comparisons. Furthermore, between-group comparisons of PF were performed using an independent *t*-test.

G*Power was used to perform a power analysis for a logistic regression model with sex as the independent variable. The alpha level was set at 0.05, and the power was set at 0.8. The analysis indicated that the minimum sample size required to achieve a power of 0.8 was 461. The present study included 745 participants; thus, the sample size was sufficient to detect significant effects [16, 17]. Logistic regression was performed to identify significant predictors of sarcopenia. For this, the forward (likelihood ratio) stepwise selection method was used, with the criteria for variable entry and removal set at 0.05 and 0.1, respectively. This analysis included age; sex (men, 1; women, 0); MNA-SF score; PA habits; and results of 30-s ACT, 8-UGT, BST, SLST, CSRT, 30-s CST, 2MST, and timed 6MWT. The discriminative ability of the model was assessed through receiver operating characteristic curve analysis; the area under the curve value was calculated to evaluate the model's predictive performance. Statistical significance was set at $p < 0.05$ for all tests and variables.

## Results

### Clinicodemographic characteristics of the study cohort

This study included 745 older adults. The sarcopenia group comprised 70 older adults (32 men and 38 women). Thus, the prevalence of sarcopenia in community-dwelling older adults residing in Taiwan's Yilan County was 9.40%. The sarcopenia group was significantly older than the nonsarcopenia group (82.0 ± 6.5 vs. 74.7 ± 6.4 years; $p < 0.05$). The proportion of men was higher in the sarcopenia group than in the nonsarcopenia group (45.7% vs. 24.7%; $p < 0.05$).

Compared with the nonsarcopenia group, the sarcopenia group exhibited low muscle mass (6.5 ± 0.9 vs. 5.6 ± 0.7 kg/m$^2$), low muscle strength (26.16 ± 7.17 vs. 19.02 ± 4.69 kg), and poor walking speed (1.17 ± 0.249 vs. 0.86 ± 0.269 m/s). The prevalence of hyperlipidemia was lower in the sarcopenia group than in the nonsarcopenia group (7.1% vs. 19.7%). Furthermore, the proportion of individuals with a poor nutritional status was higher in the sarcopenia group than in the nonsarcopenia group (12.6 ± 1.4 vs. 13.3 ± 1.1; $p < 0.05$). However, the two groups did not differ significantly in terms of PA parameters. Table 1 presents the clinicodemographic characteristics of the study cohort.

### PF of the study cohort

We performed a sex-based subgroup analysis to analyze PF in the two groups. Sarcopenia was significantly ($p < 0.05$) associated with a low body mass index, poor muscular endurance (30-s ACT and 30-s CST), poor flexibility (BST and CSRT), poor aerobic fitness (2MST), and poor balance (SLST and 8-UGT). Regardless of sex, the sarcopenia group exhibited significantly poorer performance in almost all physical and nutritional parameters than did the nonsarcopenia group ($p < 0.05$). Between-group differences were nonsignificant only for flexibility in men. Table 2 presents the PF parameters of the study cohort stratified by sex.

### Factors influencing sarcopenia risk in the study cohort

Key factors influencing the risk of sarcopenia were explored using a multivariate stepwise logistic regression model. The results are summarized in Table 3. The risk of sarcopenia increased with age (odds ratio [OR]: 1.107; 95% confidence interval [CI]: 1.401–1.177). Specifically, each additional year of age was associated with a 10.7% increase in the risk of sarcopenia ($p = 0.001$). The risk of sarcopenia was 2.881 times higher in men than in women (OR: 2.881; 95% CI: 1.407–5.899; $p = 0.004$). The OR for MNA-SF scores was 0.690 (95% CI: 0.547–0.547; $p = 0.002$), indicating that each point increase in this score was associated with a 31% reduction in the risk of sarcopenia. Furthermore, a 1-s increase in 8-UGT was associated with a 34.6% increase in the risk of sarcopenia (OR: 1.346; 95% CI: 1.174–1.544; $p < 0.05$). A receiver operating characteristic curve was constructed (Fig. 2) to visualize the discriminative ability of the logistic regression model; the area under the curve value was 0.867 (95% CI: 0.827–0.906), indicating excellent discrimination between the two groups. Therefore, the model had strong predictive power for identifying older adults at a risk of sarcopenia.

## Discussion

As mentioned, the use of a broad range of PF tests to investigate the association of sarcopenia risk with various PF components contributes to the novelty of this study, setting it apart from studies that used a limited range of

**Table 1** Clinicodemographic characteristics of community-dwelling older adults with or without sarcopenia

| | Total | Sarcopenia | Nonsarcopenia | *p* value |
|---|---|---|---|---|
| Number | 745 | 70 | 675 | |
| Male: Female (%) | 26.7:73.3 | 45.7:54.3 | 24.7:75.3 | < 0.05 |
| Age (years old) | 75.4 ± 6.8 | 82.0 ± 6.5 | 74.7 ± 6.4 | < 0.05 |
| Hypertension | 428(57.4%) | 39(55.7%) | 389(57.6%) | 0.76 |
| Diabetes | 171(23.0%) | 16(23.0%) | 155(23.0%) | 0.98 |
| Hyperlipidemia | 138(18.5%) | 5(7.1%) | 133(19.7%) | < 0.05 |
| **Sarcopenia characteristics** | | | | |
| Skeletal muscle index (kg/m$^2$) | 6.4 ± 0.9 | 5.6 ± 0.7 | 6.5 ± 0.9 | < 0.05 |
| Hand grip strength (kg) | 25.49 ± 7.28 | 19.02 ± 4.69 | 26.16 ± 7.17 | < 0.05 |
| 6-m walk speed (m/s) | 1.14 ± 0.267 | 0.86 ± 0.269 | 1.17 ± 0.249 | < 0.05 |
| **Nutrition characteristics** | | | | |
| Mini nutritional assessment | 13.3 ± 1.1 | 12.6 ± 1.4 | 13.3 ± 1.1 | < 0.05 |
| **Physical activity characteristics** | | | | |
| With physical activity habit (%) | 93.4 | 91.4 | 93.6 | 0.33 |
| > 3 /week physical activity (%) | 86.8 | 88.6 | 86.7 | 0.63 |
| Physical activity intensity (%) low: low-moderate: moderate: high[a] | 28.62:69.91:1.25:0.22 | 36.43:63.56:0:0 | 27.85:70.53:1.37:0.24 | 0.10 |

*MET* metabolic equivalent of task

[a] Low-intensity physical activity, approximately 2.5 MET; low-to-moderate-intensity physical activity, approximately 4.5 MET; moderate-intensity physical activity, approximately 6.5 MET; high-intensity physical activity, approximately 8.5 MET

**Table 2** Physical fitness of male, female, and all community-dwelling older adults with or without sarcopenia

| | Total | | | | | Male | | | | | Female | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sarcopenia | | Nonsarcopenia | | *p* | Sarcopenia | | Nonsarcopenia | | *p* | Sarcopenia | | Nonsarcopenia | | *p* |
| | N | M ± SD | N | M ± SD | | N | M ± SD | N | M ± SD | | N | M ± SD | N | M ± SD | |
| BMI (Kg/m$^2$) | 70 | 22.91 ± 2.76 | 675 | 25.47 ± 3.58 | .000 | 32 | 22.99 ± 2.62 | 167 | 25.27 ± 31.4 | .000 | 38 | 22.85 ± 2.91 | 508 | 25.53 ± 3.71 | .000 |
| Hand grip strength (kg) | 70 | 19.02 ± 4.69 | 675 | 26.16 ± 7.17 | .000 | 32 | 23.18 ± 3.19 | 167 | 34.87 ± 7.09 | .000 | 38 | 15.52 ± 2.21 | 508 | 23.30 ± 4.33 | .000 |
| Timed 6-m walk test (sec) | 70 | 8.17 ± 5.22 | 675 | 5.44 ± 1.68 | .000 | 32 | 7.27 ± 1.94 | 167 | 5.33 ± 1.39 | .000 | 38 | 8.94 ± 6.81 | 508 | 5.47 ± 1.77 | .003 |
| 30-s arm curl (n of repeats) | 66 | 14.7 ± 4.0 | 672 | 19.2 ± 4.3 | .000 | 32 | 14.3 ± 4.2 | 165 | 19.2 ± 4.9 | .000 | 34 | 15.1 ± 3.9 | 507 | 19.1 ± 4.2 | .000 |
| 30-s chair stand (n of repeats) | 66 | 12.6 ± 4.2 | 671 | 16.9 ± 5.3 | .000 | 30 | 12.2 ± 3.9 | 165 | 16.8 ± 5.7 | .000 | 36 | 13.0 ± 4..5 | 506 | 17.0 ± 5.2 | .000 |
| Back scratch (cm) | 59 | -16.87 ± 14.58 | 658 | -9.52 ± 13.66 | .000 | 26 | -19.12 ± 15.90 | 163 | -17.46 ± 14.23 | .589 | 33 | -15.11 ± 13.44 | 495 | -6.90 ± 12.42 | .000 |
| Chair sit-and-reach (cm) | 66 | -1.08 ± 8.47 | 668 | 4.57 ± 10.06 | .000 | 28 | -3.18 ± 8.32 | 163 | -1.71 ± 8.86 | .416 | 38 | 0.46 ± 8.35 | 505 | 6.60 ± 9.58 | .000 |
| 2-min step (n of steps) | 54 | 91.2 ± 24.5 | 635 | 106.1 ± 17.8 | .000 | 26 | 91.5 ± 21.1 | 158 | 106.7 ± 16.7 | .000 | 28 | 91.0 ± 27.6 | 477 | 106.0 ± 18.1 | .008 |
| Single-leg standing (sec) | 63 | 5.64 ± 7.69 | 660 | 16.64 ± 14.17 | .000 | 30 | 5.22 ± 7.20 | 161 | 18.16 ± 14.47 | .000 | 33 | 6.03 ± 8.21 | 499 | 16.15 ± 14.05 | .000 |
| 8-foot up-and-go (sec) | 70 | 11.72 ± 7.06 | 675 | 7.52 ± 2.62 | .000 | 32 | 10.44 ± 2.99 | 167 | 7.50 ± 2.63 | .000 | 38 | 12.80 ± 9.10 | 508 | 7.52 ± 2.62 | .001 |

**Table 3** Factors associated with sarcopenia

| Variable | | | | | 95.0% Confidence Interval for Exp(B) | |
|---|---|---|---|---|---|---|
| | B | Std. Error | Significant | Exp(B) | Lower Bound | Upper Bound |
| (Constant) | -8.469 | 2.787 | 0.002 | 0.000 | 19.229 | 30.146 |
| Age (years old) | 0.101 | 0.031 | 0.001 | 1.107 | 1.401 | 1.177 |
| Gender (male:1, female:0) | 1.058 | 0.366 | 0.004 | 2.881 | 1.407 | 5.899 |
| Mini Nutrition Assessment Short Form (score) | -0.371 | 0.119 | 0.002 | 0.690 | 0.547 | 0.871 |
| 8-feet up-and-go (second) | 0.297 | 0.070 | 0.000 | 1.346 | 1.174 | 1.544 |

Key factors were identified using a stepwise logistic regression model

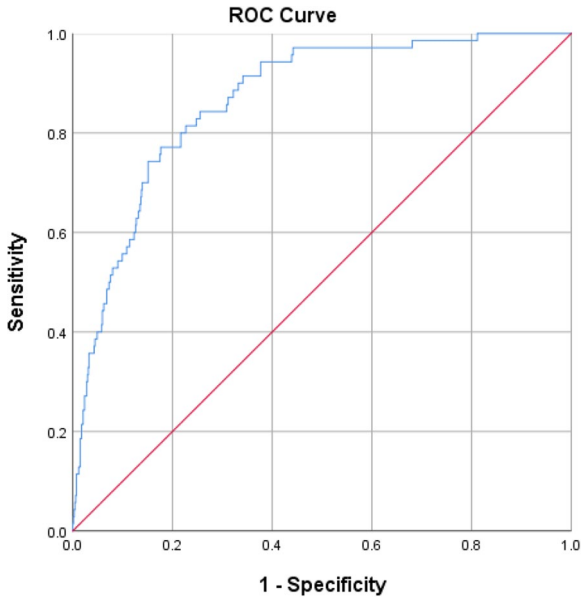


**Fig. 2** ROC curve for sarcopenia prediction. ROC curve, receiver operating characteristic curve

performance measures. Our findings highlight the practicality of tests such as 8-UGT, which is a rapid and functional tool for clinical use, and can inform personalized health promotion programs for improving health and functionality in older adults with sarcopenia.

The prevalence of sarcopenia in the study cohort was 9.40%, which is relatively low, likely because only physically fit participants capable of completing the PF tests were included in this study. Therefore, the study cohort may not fully represent the broader community of older adults, particularly those at an elevated risk of sarcopenia. This limitation indicates potential selection bias: our results are more reflective of healthier individuals and may underestimate the true prevalence of sarcopenia. Consequently, the generalizability of our findings to populations with more diverse health statuses may be limited. Moreover, certain risk factors for sarcopenia might have appeared less significant. Nonetheless, our study offers a community-based, real-world data set that can be used to monitor PF in older adults and integrated with laboratory-based data for the Taiwanese population. Although many studies have assessed body composition, muscle strength, flexibility, and cardiovascular fitness in older adults [18–20], few Taiwanese studies have directly analyzed the relationship between PF and sarcopenia status. Our study demonstrated that most PF measures were poorer in the sarcopenia group than in the nonsarcopenia group, regardless of sex, However, the groups did not differ significantly in terms of flexibility among men. Although factors such as age, sex, and nutrition are known to influence sarcopenia, the association between sarcopenia and 8-UGT results remains unclear. We conducted a broad range of PF tests to identify the association between sarcopenia and PF in community-dwelling older adults. Our findings aid the development of personalized programs that incorporate exercise and dietary guidance to improve the lifestyles of older adults with sarcopenia. In the context of rehabilitation, our findings underscore the importance of strengthening exercises, whose efficacy can be assessed through PF tests, particularly 8-UGT, during outpatient screenings. On the basis of our findings, we recommend clinicians to extend their focus beyond the disease in patients with sarcopenia to improve overall PF and functionality.

We found that standard diagnostic test results were poorer in the sarcopenia group than in the nonsarcopenia group. Most of the PF tests yielded poorer results in the sarcopenia group than in the nonsarcopenia group, regardless of sex. A study involving 431 older adults reported similar findings, indicating that both men and women with suspected sarcopenia exhibited poor muscle strength, aerobic fitness, flexibility, agility, and balance [19]. Our study revealed that only for men, upper and lower body flexibility did not differ significantly between the sarcopenia and nonsarcopenia groups

[19]. Flexibility, defined as the capacity to move a joint across its entire range of motion, is a component of health-related PF [21]. Emerging evidence suggests that stretching increases blood flow and promotes capillary formation in skeletal muscle [22], thereby influencing muscular growth and loss [23]. A study involving 857 older adults highlighted an inverse association between flexibility and sarcopenia [24]. Although we observed a similar trend in men, it was nonsignificant.

Functional fitness in the study cohort improved with the implementation of the National Ten-Year Long-Term Care Plan 2.0. HGS improved significantly in the nonsarcopenia group, regardless of sex. For women with sarcopenia, HGS was better than that reported in the literature (15.52 ± 2.21 vs. 13.5 ± 5.5 kg) [20]. By contrast, for men with sarcopenia, HGS was consistent with the value in the literature (23.18 ± 3.19 vs. 23.3 ± 9.0 kg). Therefore, our program either restored muscle strength or delayed functional decline in the participants. A Taiwanese study involving 275 older adults reported that aerobic fitness (measured using the 3-min step test) was significantly lower in patients with sarcopenia than in those with normal skeletal muscle mass [20]. In our study, the sarcopenia group performed worse in 2MST than did the nonsarcopenia group (91.2 ± 24.5 vs. 106.1 ± 17.8 steps); this finding corroborates that age-related declines in muscle strength and mass are associated with reduced aerobic fitness in older adults. Another study [25] indicated that both fat-free mass and quadriceps strength contribute to the age-related decline in aerobic fitness. Together, the findings suggest that sarcopenia management programs should incorporate both strength and cardiopulmonary training.

We explored factors influencing the risk of sarcopenia in community-dwelling older adults. Evidence suggests that factors such as age, sex, weight, height, walking speed, HGS, and sit-to-stand muscle strength can help detect sarcopenia in these individuals [26]. Appropriate nutrition, particularly the intake of whey protein with vitamins D and E, and PA can improve muscle mass and strength in older adults with sarcopenia by modulating the levels of insulin-like growth factor-I and interleukin-2 [27]. Moreover, PA can reduce the risk of sarcopenia [28]. Despite the complex associations between sarcopenia risk, nutrition, and PA, current models for detecting sarcopenia on the basis of these variables have several limitations. Our model exhibited high predictive potential for identifying older adults at an elevated risk of sarcopenia. The model indicated older age, male sex, low MNA-SF score, and poor performance in 8-UGT as key factors associated with an increased risk of sarcopenia in the study population. Notably, 8-UGT is a modified version of the timed up-and-go (TUG) test, which measures muscle strength, walking speed, agility, and dynamic balance. In clinical settings, adjustments are made in the TUG test for practicality—for example, the walking distance is reduced from 3 to 2.44 m and participants are instructed to walk to a cone, circle around it, and return, rather than turning at a marked line to increase the test's feasibility in limited spaces [29]. TUG test results can predict the development of sarcopenia. Martinez et al. reported a sensitivity of 67% and a specificity of 88.7% for the detection of sarcopenia through this test; corresponding cutoff time was 10.85 s [30]. In patients with chronic obstructive pulmonary disease, poor TUG performance was independently associated with the risk of sarcopenia, even after adjustments for disease severity [31]. A machine learning model developed using TUG test data achieved 88% accuracy in predicting the development of sarcopenia in older women [32]. Thus, the inclusion of 8-UGT in the diagnosis of sarcopenia is supported by evidence from studies using the TUG test. Both the TUG test and 8-UGT offer a simple, rapid, and practical means to assess multiple domains of PF associated with the risk of sarcopenia. However, very few studies have focused on 8-UGT in this context. Our study adds value by demonstrating that similar mobility tests can yield relevant clinical insights into the risk of sarcopenia, particularly in community settings. Future studies should directly compare the two tests in terms of their effectiveness across settings.

Physical inactivity increases the risk of sarcopenia in older adults [33], whereas PA reduces this risk by enhancing muscle strength [34, 35] and mass [36]. These findings suggest a strong negative association between PA and sarcopenia risk [28]. Resistance training is particularly effective in preventing sarcopenia [37, 38]. However, we found no significant difference in PA level between the sarcopenia and nonsarcopenia groups ($p = 0.10$), likely because the participants engaged in low-intensity PA. Although muscle mass can improve with training at an intensity of 60%–85% intensity training, building muscle strength typically requires training at an intensity of > 85% [37], which was not achieved by our sarcopenia group. This finding underscores the importance of appropriate training intensity in future health promotion programs for preventing sarcopenia in older adults.

We acknowledge the usefulness of the forced entry method in the selection of variables for a statistical model; this method provides a robust theoretical framework for variable selection. However, for the present study. we used the stepwise method because of its practical advantages, particularly in exploratory analyses. This data-driven method allows for the objective selection of variables that best predict the outcome, reducing the risks of multicollinearity and overfitting.

Factors contributing most significantly to our model—in particular, PF parameters—were automatically selected.

This study has several strengths. First, it involved a relatively large sample ($N=754$) of community-dwelling older adults (mean age: 75.4 ± 6.8 years) residing in Taiwan's Yilan County. Second, the PF tests were conducted in a real-world setting, facilitating the detection of sarcopenia through a comprehensive test battery rather than relying solely on HGS evaluation, 6MWT, and 5-time CST. The assessment approach proposed in our study does not replace the AWGS criteria; instead, it can serve as a complementary tool and inform targeted interventions, particularly for individuals having a high risk of sarcopenia and those with borderline sarcopenia. The proposed approach may be integrated into current practices to optimize sarcopenia assessment without undermining the established criteria.

Our study has some limitations. First, the cross-sectional nature of this study precluded causal inference for the relationships between sarcopenia, nutrition, and physical performance. Second, this study included only community-dwelling older adults who were functionally independent and participated in the health promotion program and excluded inpatients and patients with major illnesses. This approach may limit the applicability of our findings to a broader geriatric population. Nevertheless, our study provides insights into the efficacy of local health promotion programs in reducing the risk of sarcopenia in older adults participating in community activities. To increase the generalizability of our findings, future studies should include a diverse group of participants. Finally, PA levels were measured using self-reported data, which might not have accurately reflected actual PA levels.

## Conclusion

The prevalence of sarcopenia in community-dwelling older adults residing in Taiwan's Yilan County was 9.40%. Almost all PF parameters were poorer in the sarcopenia group than in the nonsarcopenia group, regardless of sex ($p<0.05$). Only flexibility (measured through BST and CSRT) in men did not differ significantly between the two groups. Furthermore, the results of demographic, nutritional, and PF assessments suggested that older age, male sex, malnutrition, and poor performance in 8-UGT were associated with an elevated risk of sarcopenia in community-dwelling older adults. Future research should focus on developing personalized interventions and exploring the long-term effects of such assessments to prevent or manage sarcopenia effectively.

## Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12877-024-05528-7.

Supplementary Material 1.

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**Informed consent**

Written informed consent was obtained from all participants.

**Dual publication**

The results, data, and figures presented in the manuscript have not been published elsewhere, nor are they under consideration by any other journal.

**Authors' contributions**

W-SL: Writing—original draft preparation and Data interpretation. N-WH, S-HY, and Y-TC: Participant recruitment, Data acquisition, and Project administration. C-CT: Statistical analysis. P-JP: Study design, Study supervision, Writing—review and editing, Data interpretation, and Project administration. All authors have read and approved the final version of the manuscript.

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**Data availability**

The data supporting the findings of this study have not been made publicly available to protect participant privacy. Nonetheless, data are available from the corresponding author upon reasonable request.

## Declarations

**Ethics approval and consent to participate**

This was a cross-sectional study. Medical data of older adults residing in Taiwan's Yilan County were analyzed in this study. Permission for accessing the medical data was granted by the Director of the Center of Community Medicine, National Yang Ming Chiao Tung University Hospital, Yilan. All procedures performed in this study adhered to the ethical principles of the Declaration of Helsinki and those of National Yang Ming Chiao Tung University Hospital. This study was approved by the Human Subject Research Ethics Committee of National Yang Ming Chiao Tung University Hospital (approval number: 2020A012).

**Consent for publication**

Not applicable.

**Competing interests**

The authors declare no competing interests.

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## Publisher's Note