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Physiological and psychological function differences in the formation of dynapenia, pre-sarcopenia and sarcopenia

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Abstract

Background & Objectives: The clinical significance of interaction between muscle strength and mass in sarcopenia is not clear. This cross-sectional study aimed to evaluate the characteristics between people with dynapenia, pre-sarcopenia and sarcopenia. *Methods:* Three hundred individuals aged ≥55 years were recruited from rural communities in Yunlin, Taiwan. Grip/leg strength and the skeletal muscle index were used for grouping. Socioeconomic status, chronic disease, the Short Portable Mental State Questionnaire (SPMSQ), the Brief Symptom Rating Scale (BSRS-5), the Chinese Happiness Inventory (CHI), the World Health Organization Quality of Life Brief Version (WHOQOL–BREF) questionnaire and the Mini-Nutritional Assessment Short Form (MNA-SF) were investigated by analysis of variance and multinomial logistic regression. *Results:* The pre-sarcopenia and sarcopenia groups had lower body mass index. The score on the SPMSQ was highest in the sarcopenia group. There were no significant differences in the BSRS-5 or the CHI. In the WHOQOL-BREF, the dynapenia group had lower overall and physiological scores and the sarcopenia group had lower physiological and environmental scores. The sarcopenia group had a lower score on the MNA-SF. In the regression model, key factors for the dynapenia group included age, the SPMSQ score, and the physiological score on the WHOQOL-BREF. For the pre-sarcopenia group, the key factors were age, gender, and BMI. Most of these factors were associated with sarcopenia, with the additional factor of gastrointestinal problems.
Conclusions: Our study revealed that physiological factors were more prominent in pre-sarcopenia and that cognitive function had more impact in dynapenia.

Keywords: Sarcopenia; dynapenia; pre-sarcopenia; cognition; quality of life.

INTRODUCTION

Sarcopenia is a progressive skeletal muscle disorder involving the accelerated loss of muscle mass and function. It occurs commonly as an age-related process in older people and is associated with increased adverse outcomes, including falls, functional decline, frailty and mortality.[1] Since 2018, Taiwan has had a population in which more than 14% are aged 65 years or older. The prevalence of sarcopenia was respectively 18.6%

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and 23.6% in women and men aged 65 or older[2], which may contribute to the considerable burden in healthcare.

The diagnosis of sarcopenia includes reduction of both physical performance and skeletal muscle mass.[3] The Asian Working Group for Sarcopenia (AWGS-2019) uses the terminology "possible sarcopenia" in cases who have deficient in strength yet not receive fully examination including skeletal muscle mass measurement. Consequently, possible sarcopenia in AWGS-2019 should include those had poor strength with and without abnormality in muscle mass and it implies a sequence from screening to diagnosis.[4] However, the physical strength and skeletal muscle mass were not highly associated.[5] In addition to muscle mass loss, the decrease of strength (i.e. dynapenia) may also result from disease of the neural system[6] or osteoarthropathy.[7] The European Working Group of Sarcopenia in Older People (EWGSOP1) defines a pre-state of sarcopenia, termed 'pre-sarcopenia', where the sole characteristic present is low muscle mass.[3] Although not used as a common diagnosis, pre-sarcopenia did increase all-cause mortality and should also be considered in aging health.[8] Taken together, the presence of physical weakness and loss of muscle mass forms a four-quadrant system: control, dynapenia, pre-sarcopenia and sarcopenia statuses.

There have been few studies comparing clinical significance in the four different health statuses. In a study evaluating differences of photoplethysmography parameters in the four groups, participants with pre-sarcopenia and sarcopenia were more likely to be female and those with dynapenia had a higher frequency of osteoporosis.[9] One study investigated walking gait between the groups.[10] Another study showed that cognitive impairment was more prevalent in the dynapenia and sarcopenia groups, whereas social and behavioural items were associated with pre-sarcopenia status.[11] There is a need for a more comprehensive study that encompasses physical, psychological, and socioeconomic factors to thoroughly examine the clinical significance of these conditions.

In this study, we evaluated the characteristics between the four groups: people with dynapenia, pre-sarcopenia or sarcopenia, and people without any of these conditions (control). The parameters investigated included socioeconomic, disease, psychological and nutritional status. By elucidating the risk factors, we aimed to categorize different health condition before the definite sarcopenia and to investigate their possible associative factors, so that to provide possible preventive strategies.

METHODS

Participants

This cross-sectional study was performed in Yunlin, Taiwan, from September 2021 to July 2022. We estimated that a minimum of 60 participants per group would be necessary, considering an expected sarcopenia prevalence of approximately 20%.[2] Therefore, it was determined that recruiting three hundred participants for the study would be appropriate for the analysis. We recruited people aged ≥ 55 years from two sources: individuals attending community daycare services (n = 273); and individuals not attending daycare services but referred by county officers or social workers (n = 27). People with impaired consciousness, marked cognitive impairment (clinical dementia rating = 3) or significant deficits in activities of daily living (Barthel Index ≤ 20) were excluded. The participants were offered both written and verbal explanations of the study before we obtained their formal consent. They were also made aware of the confidentiality of their information.

Measures of demography and physiological condition

Demographic data on age, gender, body mass index (BMI), education years, socioeconomic status and underlying chronic diseases were collected and the physical status (including grip strength, walking speed and time-up-and-go test) was measured using Babybot grip strength dynamometer and measuring exercise equipment (Netown Co., Taiwan). The grip strength was measured by the spring-type dynamometer in standing and full elbow extension as suggested by AWGS-2019[4], and only dominant hand was measured. The skeletal muscle index (SMI) was measured using an ACCUNIQ 380 bioimpedance analyser (SELVAS Healthcare, South Korea). The participants were asked to remove metal accessories to avoid their influence on electrical impedance. Cut-off values of the parameters for sarcopenia were in accordance with the 2019 consensus of the AWGS-2019.[4] Low grip strength is defined as handgrip strength < 28 kg for men and < 18 kg for women; and abnormality in the five-time chair stand test is defined as ≥ 12 seconds. The timed-up-and-go test (TUG)

was used instead of a 6-metre walking speed due to the adaptability of the equipment, with a duration of > 13.9 seconds considered abnormal.[12] Abnormalities of height-adjusted muscle mass were also in accordance with the AWGS-2019 (< 7.0 kg/m^2 in men and < 5.7 kg/m^2 in women).

Measures of psychological condition

Psychological status was measured with the Short Portable Mental State Questionnaire (SPMSQ), the Brief Symptom Rating Scale (BSRS-5), the Chinese Happiness Inventory (CHI) and the World Health Organization Quality of Life Brief Version (WHOQOL–BREF) questionnaire. The SPMSQ is a commonly used test of cognitive function, with 10 questions that measure dimensions such as orientation, memory and digit calculation.[13] All items are dichotomous and an incorrect answer to three or more questions indicates that the respondent has impaired cognitive function. The BSRS-5 has five main dimensions (sleep disturbance, anxiety, irritability, depression and inferiority) and suicidal ideation was explored as an additional question.[14] This scale exhibits satisfactory psychometric properties (Cronbach's alpha = 0.77–0.90 for community samples) and is therefore widely employed for assessing mental health in Taiwan.[15] Evaluation is based on the experience of the previous week and adopts a five-point Likert scale (0–4), with a higher score indicating higher severity. The 10-item version of the CHI, developed by Lu *et al*. for assessing the degree of happiness, has robust validity and reliability data in the context of Taiwan.[16] The CHI has six subscales: optimism, positive affect, physical fitness, satisfaction with self, achievement at work and peace of mind. The scores are based on subjective feelings in the last three months using a four-point Likert scale (0–3). Only the total score was analysed in the present study. Psychological satisfaction was evaluated by measuring quality of life (QOL) with the WHOQOL-BREF questionnaire, a shortened version of the WHO Quality of Life-100 questionnaire that evaluates multiple facets of QOL. There are 26 items on the international version of the WHOQOL-BREF; however, the Taiwanese version, based on research by Yao *et al*.[17], comprises 28 items divided into two sections: overall QOL questions; and questions relating to four specific domains of QOL (physical, psychological, social and environmental). Responses are made on a five-point Likert scale. A psychometric study conducted in Taiwan demonstrated that the WHOQOL–BREF exhibits strong internal consistency (Cronbach's alpha = .91).[17]

Measures of nutrition condition

Nutritional status was evaluated by the Mini Nutritional Assessment Short Form (MNA-SF), which has six questions and a total score ranging from 0 to 14.[18] Scores of ≤ 11 suggest a risk of nutritional insufficiency and scores of ≤ 7 suggest poor nutritional status. The MNA-SF has been shown to have similar effectiveness to the full version.[19]

Grouping of participants

The grouping of subjects was based on physical statuses and the cut-off values were based on the criteria of AWGS-2019. The dynapenia group included participants with any abnormality in physical capability (grip strength, five-time chair stand test or TUG) and with normal SMI results. The pre-sarcopenia group included those with normal physical capability but with abnormal SMI. The control group had normal physical capability and SMI whereas in the sarcopenia group these factors were abnormal.

Statistical analyses

We supplemented the demographic data with a descriptive analysis. Continuous variables were expressed with means and their standard deviations; and categorical variables were expressed with numbers and percentages. We compared demographic, physical, psychological and nutritional data between the four pre-defined groups (control, dynapenia, pre-sarcopenia and sarcopenia) using one-way analysis of variance (ANOVA). Scheffé's method was used for post-hoc analyses on the parameters that showed a significant difference within the four groups.

To establish a model, we used multinomial logistic regression analysis with a stepwise method, treating the demographic data, BMI, overall and individual scores of the WHOQOL-BREF and scores of the SPMSQ, BSRS-5, CHI and MNA-SF as independent variables. Physical performance (grip strength, five-time chair stand test or TUG) and SMI were excluded from the model because they were used in the categorizing groups. In addition, the SARC-F score and shin circumference were excluded because they were also screening tools for sarcopenia in the AWGS-2019. Categorical items were set as dichotomous dummy variables. The model used the control

group as a reference to calculate the odds ratio of the other three groups. The above analyses were two-sided, with an alpha value of 0.05. The analyses were conducted using IBM SPSS Statistics (Version 25; IBM Corp., Armonk, NY).

RESULTS

Demographics

Demographic data for 300 older people (75 with sarcopenia, 27 with pre-sarcopenia, 104 with dynapenia and 94 controls) were collected in this study (Table 1). The mean age was higher in the sarcopenia group (78.33) than in the pre-sarcopenia group (75.3) or the dynapenia group (75.12) and the control group was the youngest (71.11; $p < 0.001$) (Figure 1a). Fewer participants with sarcopenia (11.3%) or dynapenia (23.7%) received higher education than those in the pre-sarcopenia (40.9%) and control groups (43.2%; $p<0.001$) (Figure 1b). More people in the control (61.4%) and dynapenia groups (63.6%) still had a spouse than in the pre-sarcopenia group (38.5%, $p=0.043$; Figure 1c). Meanwhile, the control group had the highest number with adequate living expenses (14.9%) than the other groups ($p=0.029$; Figure 1d). There were no significant differences in number of children, single living, employment, smoking/alcohol-drinking habits or clinical diseases between groups.

Physical, psychological and nutritional status

Comparisons of physical, psychological and nutritional status are shown in Table 2. With regard to physical status, the prerequisite conditions for categorizing sarcopenia groups contributed to the differences in grip strength, five-time chair stand test, TUG and SMI. In addition, the pre-sarcopenia and sarcopenia groups had lower BMI (21.96 and 22.05 vs. 25.73 and 26.0 kg/m^2, $p<0.001$) and shin circumferences (31.53 and 30.52 vs. 34.87 and 34.51 cm, $p<0.001$) than the other groups (Figure 1e). On the other hand, the dynapenia and sarcopenia groups had higher SARC-F scores than the other groups (1.4 and 1.6 vs. 0.47 and 0.30, $p<0.001$).

In the psychological domain, the mean SPMSQ score was lowest in the control group (0.95), followed by the pre-sarcopenia (1.48), dynapenia (1.89) and sarcopenia groups (2.97; $p<0.001$) (Figure 1f), suggesting differences in cognitive dysfunction. There were no significant differences in the BSRS-5 (psychopathology) or CHI (happiness) score between groups. The overall WHOQOL-BREF score was higher in the control group (14.45) than in the dynapenia group (13.02, $p=0.004$, Figure 1h). The score in the physical domain was higher in the control and pre-sarcopenia groups (14.93 and 15.53 vs. 13.72 and 13.94, $p<0.001$, Figure 1i). There was a difference in the scores for the psychological domain, although post-hoc analyses showed no significant difference (Figure 1j). In the environmental domain, the control group had a significantly higher score than in the sarcopenia group (16.37 vs. 15.15, $p=0.006$, Figure 1k).

In the nutrition domain, participants in the control and dynapenia groups had higher scores than those in the sarcopenia groups (13.37 and 13.11 vs. 12.32, $p<0.001$, Figure 1g).

Multinomial logistic regression model

In the model, six factors that were able to differentiate the sarcopenia condition remained significant: age, gender, gastrointestinal problems, BMI, the SPMSQ score and the physiological domain score of the WHOQOL-BREF (Table 3). Age was predictive for all the three other groups, with the odds ratio increasing from dynapenia (OR=1.055, $p=0.02$) to pre-sarcopenia (OR=1.086, $p=0.038$) to sarcopenia (OR=1.114, $p=0.001$). Additional risk factors of dynapenia included a lower score on the SPMSQ (OR=0.704, $p=0.002$) and the physiological score of the WHOQOL-BREF (OR=0.801, $p=0.002$). Additional risk factors of pre-sarcopenia included being male (OR=4.808, $p=0.008$) and a lower BMI (OR=0.549, $p<0.001$). Additional risk factors of sarcopenia not only overlapped with those in the pre-sarcopenia group, including being male (OR=5.882, $p<0.001$) and a lower BMI (OR=0.538, $p<0.001$), but also partially overlapped with those in the dynapenia group, including a lower SPMSQ score (OR=0.532, $p<0.001$). Furthermore, having gastrointestinal problems added extra risk for the sarcopenia group (OR=2.564, $p=0.04$).

DISCUSSION

In this study, we evaluated the characteristics of four groups of older people: those with dynapenia, pre-sarcopenia or sarcopenia, and people without any of these conditions. In this community sample, the number of participants with dynapenia was more than the numbers with pre-sarcopenia and sarcopenia. Although the lower number in pre-sarcopenia group may increase variability, we

Table 1: The demographics and sarcopenia conditions

	Control (n = 94) Mean/n (±SD/%)	Dynapenia (n = 104) Mean/n (±SD/%)	Pre-sarcopenia (n = 27) Mean/n (±SD/%)	Sarcopenia (n = 75) Mean/n (±SD/%)	F	Statistic p-value
Demographics						
Gender (male)	19 (20.2%)	26 (25%)	9 (33.3%)	25 (33.3%)	1.50	0.213
Age (years old)	71.11 (±7.31)	75.12 (±7.19)	75.30 (±5.71)	78.33 (±6.56)	15.37	<0.001***
Education level (high school or above)	38 (43.2%)	22 (23.7%)	9 (40.9%)	8 (11.3%)	8.12	<0.001***
Marital status (having spouse)	54 (61.4%)	63 (63.6%)	10 (38.5%)	34 (48.6%)	2.75	0.043*
Living expenses (>24k NTD/month)	13 (14.9%)	5 (5.0%)	1 (4%)	3 (4.3%)	3.07	0.029*
Number of children	3.26 (±1.02)	3.69 (±1.06)	3.52 (±1.29)	3.47 (±1.25)	2.26	0.082
Living in single	23 (25.6%)	27 (27.3%)	9 (34.6%)	17 (23.9%)	0.39	0.756
Working status (having a job)	14 (15.6%)	23 (22.5%)	8 (30.8%)	18 (25%)	1.25	0.289
Smoking	5 (5.6%)	8 (7.8%)	3 (12%)	8 (11.1%)	0.38	0.549
Alcohol drinking	4 (4.5%)	10 (9.8%)	2 (7.7%)	6 (8.3%)	0.66	0.577
Healthy conditions						
Having psychiatric problems	13 (15.3%)	23 (24.0%)	4 (16%)	13 (19.1%)	0.79	0.698
Having cardiovascular problems	48 (57.1%)	62 (63.3%)	11 (50%)	36 (54.5%)	0.68	0.564
Having gastrointestinal problems	3 (3.6%)	10 (10.2%)	3 (13.0%)	10 (15.4%)	2.14	0.095
Having neurological problems	6 (7.5%)	4 (4.3%)	1 (4.5%)	5 (8.2%)	0.44	0.724
Having respiratory problems	3 (3.6%)	6 (6.1%)	0	2 (3.1%)	0.74	0.522
Having urological problems	7 (8.8%)	11 (11.8%)	2 (9.1%)	9 (14.8%)	0.45	0.711
Having endocrine problems	24 (28.2%)	42 (42.9%)	8 (34.8%)	18 (26.9%)	2.09	0.101

*p<0.05; **p<0.01; ***p<0.001
NTD, New Taiwan Dollar

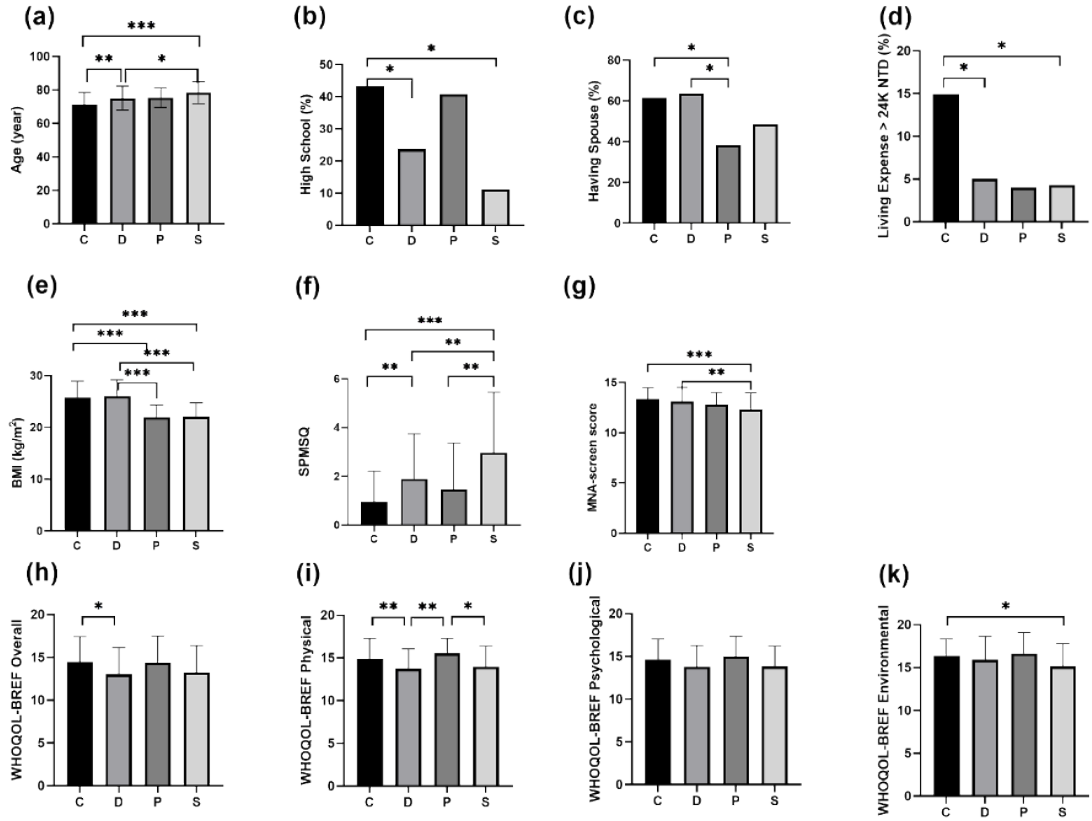

Figure 1. Post-hoc analyses of significant characteristics between sarcopenic status
(a-d) analyses of demographic characteristics; (e-k) analyses of physiological, psychological, and nutritional characteristics.
*p<0.05; **p<0.01; ***p<0.001; BMI, body mass index; MNA, Mini Nutritional Assessment; SPMSQ, Short Portable Mental State Questionnaire; WHOQOL-BREF, World Health Organization Quality of Life-BREF Questionnaire

did not observe this trend as shown in Table 2. This finding may imply the high homogeneity in that group. Multiple factors showed significant differences between these groups, including age, education, marital status, living expense, BMI, cognitive function (SPMSQ), QOL and nutritional status (MNA-SF). In the multinominal regression model, age, gender, gastrointestinal problems, BMI, the SPMSQ score and the physiological score of the WHOQOL-BREF preserved their significance to explain the differences between those groups. Among these factors, age was common to all three disease groups. Factors shared in the pre-sarcopenia and sarcopenia groups were related to physiological background (gender, BMI and a trend for gastrointestinal problems). On the other hand, cognitive dysfunction (SPMSQ) was a common risk factor in the dynapenia and sarcopenia groups. These findings provided a possible model as a double-hit mechanism combining physiological and cognitive factors to explain the formation of sarcopenia according to the current diagnostic criteria.

Age is known to be the predominant risk factor for sarcopenia.[20] An epidemiological study reported that the prevalence of relative skeletal muscle mass abnormalities increased as patients aged, with prevalences by age group of 2%, 4%, 16%, and 34% for those in their 50s, 60s, 70s and aged > 79 years.[21]

Male gender had a higher odds ratio for pre-sarcopenia and sarcopenia in our study. In the community cohort in Taiwan, the occurrence of sarcopenia and low muscle mass was higher in males, whereas physical performance showed the opposite gender difference trend.[11] Another study also demonstrated that pre-sarcopenia was lower in females in a Kosovan population.[22]

Lower BMI was also a common risk factor in the pre-sarcopenia and sarcopenia groups. A

Table 2: Physical, psychological, and nutritional status between sarcopenic status

	Control (n = 94) Mean (±SD)	Dynapenia (n = 104) Mean (±SD)	Pre-sarcopenia (n = 27) Mean (±SD)	Sarcopenia (n = 75) Mean (±SD)	F	Statistic p-value
Physical Status						
BMI (kg/m^2)	25.73 (±3.18)	26.0 (±3.20)	21.96 (±2.36)	22.05 (±2.69)	36.95	<0.001***
SARC-F	0.47 (±0.85)	1.40 (±1.75)	0.30 (±0.61)	1.6 (±1.72)	13.27	<0.001***
Shin circumference (cm)	34.87 (±2.77)	34.51 (±3.34)	31.53 (±2.02)	30.52 (± 3.17)	38.11	<0.001***
Grip strength (kgw)	25.39 (±5.89)	18.99 (±6.64)	25.04 (±6.33)	17.54 (±4.95)	32.89	<0.001***
5-time chair stand test (sec)	8.73 (±1.96)	13.43 (±4.77)	7.81 (±2.22)	14.55 (±6.08)	37.96	<0.001***
Timed up and go (sec)	7.86 (±1.72)	10.90 (±3.85)	8.25 (±2.47)	13.65 (±7.95)	22.88	<0.001***
SMI	6.68 (±0.71)	6.68 (±0.82)	5.79 (±0.72)	5.62 (±0.69)	41.82	<0.001***
Psychological Status						
SPMSQ	0.95 (±1.26)	1.89 (±1.86)	1.48 (±1.89)	2.97 (±2.48)	16.40	<0.001***
BSRS-5	2.44 (±2.69)	3.65 (±3.56)	2.54 (±2.98)	3.32 (±3.88)	2.53	0.058
CHI	18.79 (±5.13)	16.59 (±5.35)	19.35 (±5.76)	16.61 (±5.84)	2.26	0.082
WHOQOL-Overall	14.45 (±2.95)	13.02 (±3.15)	14.37 (±3.14)	13.23 (±3.17)	4.48	0.004**
WHOQOL-Physical	14.93 (±2.36)	13.72 (±2.34)	15.53 (±1.78)	13.94 (±2.43)	7.63	<0.001***
WHOQOL-Psychological	14.61 (±2.43)	13.75 (±2.50)	15.01 (±2.35)	13.83 (±2.36)	3.63	0.013*
WHOQOL-Environmental	16.37 (±1.98)	15.91 (±2.75)	16.64 (±2.45)	15.15 (±2.65)	4.22	0.006**
WHOQOL-Social	15.80 (±2.39)	15.71 (±2.43)	15.96 (±2.39)	15.27 (±2.73)	0.84	0.471
Nutritional Status						
MNA-SF score	13.37 (±1.11)	13.11 (±1.43)	12.81 (±1.20)	12.32 (±1.66)	8.35	<0.001***

*p<0.05; **p<0.01; ***p<0.001

BMI, body mass index; BSRS-5, Brief Symptom Rating Scale-5; CHI, Chinese Happiness Inventory; MNA-SF, Mini Nutritional Assessment – Short Form; SPMSQ, Short Portable Mental State Questionnaire; WHOQOL, World Health Organization Quality of Life-BREF Questionnaire

Table 3: Multinominal logistic regression models about the sarcopenic status and health characteristics

	Dynapenia		Pre-Sarcopenia		Sarcopenia				
	OR (95%CI)	***p* value**	**OR (95%CI)**	***p* value**	**OR (95%CI)**	***p* value**	**Chi²**	**df**	**$R^{2\,\#}$**
Age	1.055 (1.009-1.104)	0.020*	1.086 (1.005-1.174)	0.038*	1.114 (1.046-1.186)	0.001**	13.474	3	
Gender (male)	1.692 (0.802-3.559)	0.167	4.808 (1.497-15.385)	0.008**	5.882 (2.183-15.873)	<0.001**	14.204	3	
Having gastrointestinal problems	0.796 (0.387-1.634)	0.534	2.584 (0.876-6.690)	0.085	2.564 (1.042-6.289)	0.040*	8.810	3	
BMI	1.002 (0.910-1.102)	0.972	0.549 (0.445-0.677)	<0.001***	0.538 (0.451-0.643)	<0.001**	106.444	3	
SPMSQ	0.704 (0.564-0.880)	0.002**	0.723 (0.512-1.022)	0.067	0.532 (0.407-0.694)	<0.001**	26.724	3	
WHOQOL-Physiological	0.801 (0.696-0.922)	0.002**	1.184 (0.926-1.513)	0.179	0.874 (0.728-1.049)	0.147	18.202	3	
Overall							205.516	18	0.502

*p<0.05; **p<0.01; ***p<0.001

BMI, body mass index; SPMSQ, Short Portable Mental State Questionnaire; WHOQOL, World Health Organization Quality of Life-BREF Questionnaire. # R^2 was calculated via Cox and Snell method

longitudinal study found that BMI, bone mineral density and osteoporosis deteriorated significantly more in the healthy population who became pre-sarcopenic after 5 years.[23] Nutritional status using the MNA-SF showed differences between the four groups in our study but was dropped in the multinominal regression model. Meanwhile, the gastrointestinal problem was higher in the sarcopenia group. Although the odds ratio did not show significance in the pre-sarcopenia group, this may be because of the lower number having a higher confidence interval in this group. A previous study showed that nutritional risk was higher in those with sarcopenia but not in those with dynapenia.[24] A high prevalence of pre-sarcopenia was also seen in patients who had chronic liver disease[25], hepatocellular carcinoma[26] or received gastrectomy.[27] In patients with inflammatory bowel disease, the prevalences of pre-sarcopenia and sarcopenia were 44.6% and 50.8%, respectively, suggesting an important role for nutrient absorptive function in the development of pre-sarcopenia and sarcopenia.[28]

Cognitive function impairment was shown in the dynapenia and sarcopenia groups. Low cognition was nearly fourfold more likely in association with dynapenia[29] and hip abductor weakness as a surrogate marker for lower limb strength.[30] A lower Mini-Mental State Examination (MMSE) score predicted a higher likelihood of physical weakness but not of muscle mass.[11] In a study investigating muscle mass and function in patients with Alzheimer's disease, both the handgrip and leg strength decreased gradually in association with dementia stage, but muscle mass only decreased significantly to a moderate stage.[31] On the other hand, pre-sarcopenia did not increase the risk of dementia.[32] Although the odds ratio of pre-sarcopenia for cognitive dysfunction increased in the study of community-dwelling Korean women, the abnormal SMI was similar between the non-sarcopenia and pre-sarcopenia groups to that in the sarcopenia group.[33] Consequently, cognitive dysfunction should have a more important role in dynapenia than in pre-sarcopenia.

Although the psychopathological domain, including depression (BSRS-5) and happiness (CHI), did not show significant differences between groups, their presentations in dynapenia and sarcopenia were more alike in comparison with the other two groups. Older people who had higher stress, depressed mood and suicidal ideation showed decreased handgrip strength after adjusting the BMI.[34] In the same study, participants with a lower household income and education level also showed higher severity of depressed mood[34], suggesting that psychological and socioeconomic status were mutually affected and made a contribution in dynapenia.

Our study also demonstrated differences in multiple subdomains of QOL between the sarcopenia groups; the physiological domain was also significant in the model but only in the dynapenia group. QOL can be considered as a parameter of satisfaction with health and also interpretated as a psychological characteristic. Various studies suggested decreased QOL in patients with sarcopenia, especially in the physical function domain[35,36], but there were no further analyses for the dynapenia or pre-sarcopenia groups, except for a cohort in the UK where decreased handgrip strength was correlated with physical health and the general health domain of QOL using the SF-36 questionnaire.[37]

It is intuitive that sarcopenia is preceded by either physical performance deterioration (dynapenia) or muscle mass degeneration (pre-sarcopenia), and we found that the association factors in sarcopenia also occurred in either dynapenia (SPMSQ, WHOQOL) or pre-sarcopenia (BMI, and marginal significant in gastrointestinal problems). In regards of the possibility of two direction of causality, we may have two possible schemas (Figure 2). By comparison, the scheme A contains less assumption than scheme B, and is

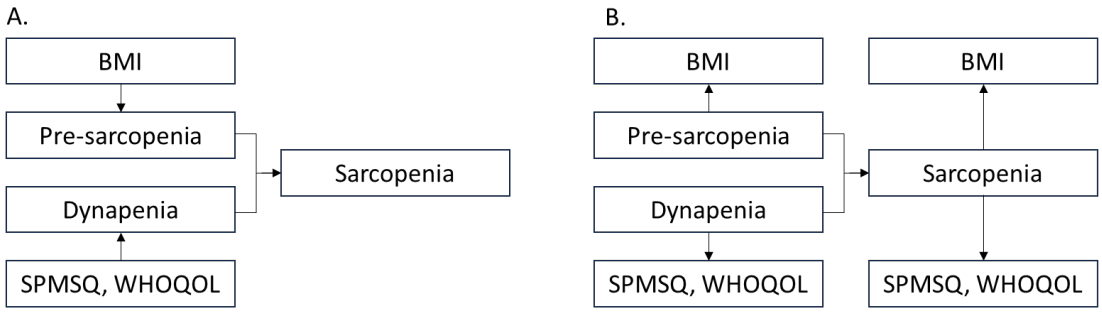

Figure 2. Two possible schemas of risk factors and sarcopenia

more possible according to the rule of novacula Occami.

The study faced limitations in establishing causality due to its cross-sectional design. Moreover, the participant pool predominantly consisted of individuals from specific community areas, which limits the generalizability of the findings to older adults with poorer health statuses. Further validation can be performed in places with disabled older people, such as nursing institute. The use of TUG test as measurement of muscle performance due to the space limitation is different from the original definition by AWGS-2019, but both of them are parameters of muscle performance. Despite these constraints, the study did offer potential hypotheses for the development of sarcopenia.

In conclusion, our study revealed possible risk factors of dynapenia, pre-sarcopenia and sarcopenia. The physiological factors were more prominent in patients with pre-sarcopenia, whereas psychological or cognitive function had more impact in dynapenia. Patients with sarcopenia may have impairments in both physiological and psychological function.

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DISCLOSURE

Ethics: The project received approval from the Research Ethics Committee at the National Taiwan University Hospital (202107168RINA).

Data availability: The data that support the findings of this study are available from the corresponding author upon reasonable request.

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