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Malnutrition, Family Support, and Possible Sarcopenia in Patients Undergoing Transcatheter Aortic Valve Implantation

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Background: Possible sarcopenia, aortic valve stenosis, and malnutrition are important issues that afflict older adults. **Objective:** The aims of this study were to compare the differences in nutritional status and family support in older adults with possible sarcopenia and those without sarcopenia after undergoing transcatheter aortic valve implantation (TAVI) and to identify the predictors of malnutrition and demonstrate changes in heart function over time after undergoing TAVI. **Methods:** A case-control design was conducted. Possible sarcopenia was identified by measuring calf circumference, grip strength, and gait speed. The Mini Nutritional Assessment-Short Form and numerical family support rating scale were used to collect data. Left ventricular ejection fraction and New York Heart Association (NYHA) functional class were assessed at 5 time points to evaluate heart function. **Results:** Eighty-one participants were categorized into those without sarcopenia (34) and those with possible sarcopenia (47). Logistic linear regression showed albumin and possible sarcopenia to be predictors of malnutrition (odds ratio, 5.5; 95% confidence interval, 1.02–30.19). Family support was associated with nutrition status ($P = .019$). For patient heart function, the results of NYHA functional class and left ventricular ejection fraction improved over time after TAVI. The improvement in NYHA functional class at T2 was significantly different between the 2 groups compared with that at T0. **Conclusions:** The nutrition level was higher among participants without sarcopenia than those with possible sarcopenia. Approximately 90% of the participants indicated that they had high family support. Demographic factors and albumin levels could be used to evaluate risk of malnutrition. Patients without possible sarcopenia showed greater improvement in NYHA class.

KEY WORDS: nutrition status, sarcopenia, transcatheter aortic valve implantation

Aortic valve stenosis can be considered the most common age-related degenerative disease. Compared with traditional aortic valve replacement, transcatheter aortic valve implantation (TAVI) causes less blood loss during the operation, a lower incidence of cerebrovascular accidents, and a less-acute kidney injury. Transcatheter aortic valve implantation can help to preserve left ventricular ejection fraction (LVEF) and manage symptomatic aortic valve stenosis.[1,2] Heart function outcomes include LVEF and New York Heart Association (NYHA) class improvement after surgery.

Sarcopenia is a concern in older adults and is related to activity, disease, and nutrition.[3] The pathophysiology of sarcopenia is complex and involves aging, physical deterioration, lifestyle, chronic diseases, and living conditions. Neural and hormonal changes; sex; genetics; malnutrition; inadequate protein; sedentary lifestyle; smoking; drinking; diseases, such as chronic pulmonary obstruction diseases,

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diabetes mellitus, and chronic kidney disease; starvation; and weight loss are the factors that reduce muscle mass and physical function, causing sarcopenia.[3]

The European Working Group on Sarcopenia in Older People defines sarcopenia as a condition of patients who experience low muscle strength. Patients with possible sarcopenia are given a diagnosis of having low muscle strength. In Asia, Asian Working Group of Sarcopenia 2019 recommends early identification of the condition and risk of sarcopenia. The criteria include low muscle strength or reduced physical performance.[4,5] Although the syndromes of sarcopenia and frailty partly overlap, frailty, defined as multisystem impairment associated with increased vulnerability to stressors, is self-reported low physical activity and exhaustion, which are classified as syndromes of sarcopenia.[6,7]

Lim and Lee[8] (2019) found that the quality of diet was poor among older people who are single. Notably, nutritional status as a behavioral factor is an important, reversible cause of sarcopenia, and dietary intake has been reported to be associated with factors that relate to family status.[9] Numerous study authors have suggested that family support should be seen as an important factor for psychological well-being, successful aging, and quality of life for older people.[10,11] An interventional study demonstrated that a family-centered strategy led to improved nutritional status in critically ill patients and that increased knowledge of nutrition among families increases family participation.[12] Research has shown that a family's dining together and the presence of assistants and caregivers are factors associated with dietary behavior in older adults; older individuals who dine alone are more likely to experience malnutrition or indigestion.[13]

The authors of this study aimed to compare the differences in nutritional status and family support in the older age groups with possible sarcopenia and those without sarcopenia after undergoing TAVI. They also attempted to identify predictors of malnutrition and demonstrate changes in heart function over time after undergoing TAVI.

Methods

Study Design and Setting

Patients included in the present case-control study were those who received TAVI and were given a diagnosis of having severe aortic valve stenosis without sarcopenia or with possible sarcopenia. A convenience sampling was adopted. The authors of this study used part of the data from the "Resilience, Nutrition, and Physical Activity in Sarcopenia Older Adults with Cardiovascular Disease—Qualitative and Quantitative Longitudinal Research Project," which included participants with cardiovascular diseases and sarcopenia and who may have coronary heart disease or valvular heart disease. From the project, we selected only participants who received the TAVI procedure. Furthermore, we divided the participants into 2 groups: without sarcopenia or with possible sarcopenia. Diagnosis of possible sarcopenia was made by measuring handgrip strength, gait speed, and calf circumference based on revised European Working Group on Sarcopenia in Older People criteria with the Asian Working Group of Sarcopenia cutoff (handgrip strength of <27 kg for men and <16 kg for women, gait speed with a cutoff point of ≤0.8 m/s, and calf circumference of <34 cm for men and <33 cm for women).[4,5]

A demographic questionnaire, the Mini Nutritional Assessment-Short Form (MNA-SF), and a numerical rating scale for family support were used to collect data once at baseline in an outpatient clinic during patient return visit. On the basis of LVEF and NYHA functional class, the authors of this study assessed patients' heart function from patient medical records at 5 time points: baseline (before TAVI); 3, 6, and 12 months after TAVI; and beyond 12 months after TAVI (denoted T0, T1, T2, T3, and T4, respectively). Because low ejection fraction (<40%) may indicate heart failure or cardiomyopathy, we defined LVEF of greater than 40% as normal heart function and less than 40% as poor.

Study Population

We recruited patients admitted to the cardiovascular department and outpatient clinic of a general hospital in Northern Taiwan between March and August 2015. The study and its protocols were approved by the institutional review board (IRB no. [587]105A-56), and the investigation conforms to the principles outlined in the Declaration of Helsinki. All participants received a verbal explanation of the study process and were informed that there were no negative consequences of withdrawal from the study at any time. Written consent was obtained before participation in the study. The average completion time for all questionnaires was less than 20 minutes.

The sample size was determined using G*Power version 3.1 (Department of Criminology, University of Melbourne, Parkville, Victoria, Australia), with the significance level set at $\alpha = .05$, statistical power at $(1 - \beta) = 0.80$, and effect size at 0.3. Effect size was estimated using the study by Saghafi-Asl and Vaghef-Mehrabany[14] and Cohen calculation equation. On the basis of the G*Power calculation, a minimum of 58 participants were required, with 29 in each group. At an estimated 10% loss rate, at least 32 participants are required for each group. Inclusion criteria were (1) diagnosis of severe aortic valve stenosis and receipt of TAVI, (2) being older than 65 years, (3) ability to read and write Mandarin or Taiwanese, and (4) willingness to participate in the study. Exclusion criteria were diagnoses of a neoplasm or psychiatric problems.

Questionnaires and Data Collection

For the purpose of demographic and clinical data collection, the researcher reviewed participants' medical

records up to 3 months before recruitment, including body mass index (BMI; kg/m^2) and laboratory data, which included serum creatinine (mg/dL), serum albumin (mg/dL), and high-density lipoprotein levels; LVEF; NYHA functional class; and other clinical data. In addition, other relevant information were collected, as shown in Table 1, such as diet preparation, physical activity, and so on.

The MNA-SF was developed by Rubenstein et al[15] for nutritional evaluation and includes 6 items: decline in food intake, weight loss, mobility, psychological stress or acute disease, BMI, and calf circumference. Each item is scored using a numerical scale (0, severe; 3, no problem) to yield a maximum score of 14. A score of 12 to 14 points indicates normal nutritional status, a score of 8 to 11 points shows the risk of malnutrition, and a score of 0 to 7 points indicates malnourished status. The MNA-SF has a Cronbach α of 0.78, a sensitivity of 96%, and a specificity of 98% for identification of malnutrition, suggesting good internal reliability or consistency and validity.[16–18]

Family support was assessed using a self-reported numerical rating scale from 0 to 10 to classify participants' feelings of family support in several aspects of life, such as living, economic, mental, and caring situations. The meaning of each numbered response was explained by a researcher, enabling the participant to choose the appropriate number.[19] More specifically, a score of 8 to 10 points indicates high family support, a score of 4 to 7 indicates medium family support, and a score of 1 to 3 points indicates minor family support.

Statistical Analysis

Demographic and medical data were analyzed using descriptive statistics, including frequencies, percentages, means, and standard deviations. A Mann-Whitney *U* test and a χ^2 test were used to compare the results of the 2 groups. A Mann-Whitney *U* test, 1-way analysis of variance, and Pearson correlation were conducted to examine the relationships among demographics, nutritional status, and family support. Binary logistic regression was conducted to determine the correlation between variables, and hierarchical regression was used to identify contributors to good nutritional status. The Mann-Whitney *U* test was used to evaluate differences in heart function between the 2 groups. All data were analyzed using SPSS (version

TABLE 1 Demographic and Clinical Data

Variable	Total (N = 81)	Without Sarcopenia (n = 34)	Possible Sarcopenia (n = 47)	Z/χ^2	*P*
Demographics, n (%)					
Sex				3.105	.078
Male	36 (44.4)	19 (55.9)	17 (36.2)		
Female	45 (55.6)	15 (44.1)	30 (63.8)		
Living situation				2.373	.305
With spouse or child	45 (55.6)	16 (47.1)	29 (61.7)		
With spouse and child	28 (34.6)	15 (44.1)	13 (27.7)		
Alone	8 (9.9)	3 (8.8)	5 (10.6)		
Caregiver[a]				0.099	.753
Self-care	46 (56.8)	20 (58.8)	26 (55.3)		
Care by others	35 (43.2)	14 (41.2)	21 (44.7)		
Diet preparation				0.073	.787
Self-prepared	73 (90.1)	31 (91.2)	42 (89.4)		
Eat out	8 (9.9)	3 (8.8)	5 (10.6)		
Physical activity				7.934	.005
No	20 (24.7)	3 (8.8)	17 (36.2)		
Yes	61 (75.3)	31 (91.2)	30 (63.8)		
Medical record, mean (SD)					
Age	78.16 (7.95)	74.44 (7.29)	80.85 (7.36)	–3.583	<.001
BMI, kg/m^2	23.66 (3.75)	24.38 (4.09)	23.15 (3.43)	–1.331	.183
Creatinine, mg/dL	2.01 (2.47)	1.38 (1.24)	2.47 (3.01)	–2.165	.030
Albumin, g/dL	3.27 (0.58)	3.49 (0.53)	3.10 (0.56)	–3.357	.001
HDL, mg/dL	46.57 (17.87)	46.17 (17.91)	46.94 (18.11)	–0.434	.663
Hb, g/dL	10.92 (2.29)	11.47 (2.02)	10.53 (2.41)	–1.259	.208
Heart function					
LVEF				0.608	.428
>40%	70/81 (87.5)	29/34 (85.3)	41/46 (89.1)		
<40%	10/81 (12.5)	5/34 (14.7)	5/46 (10.9)		
NYHA functional class[a]				0.481	.786
I/II	4/81/ (4.9)	2/23 (8.7)	2/32 (6.3)		
III/IV	51/81 (92.7)	21/23 (91.3)	30/32 (93.8)		

Abbreviations: BMI, body mass index; Hb, hemoglobin; HDL, high-density lipoprotein; LVEF, left ventricular ejection fraction; NYHA, New York Heart Association.

[a]A person (usually a relative) who tends to someone who needs personal services.

[b]Class I, no symptoms with ordinary physical activity; class II, symptoms with ordinary activity; class III, symptoms with less than ordinary activity, marked limitation of activity; class IV, symptoms with any physical activity or at rest.

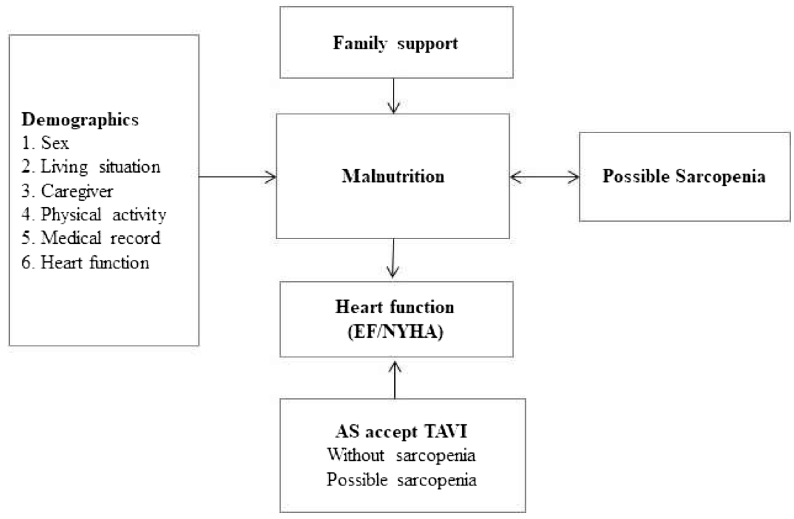

FIGURE 1. *Conceptual framework. TAVI, transcatheter aortic valve implantation.*

20.0 for Windows; Chicago, Illinois), with the significance level set at .05. The design of the study is shown in Figure 1. As seen in the figure, demographics and family support affected nutrition status, whereas nutrition status and TAVI procedure influenced heart function. In addition, nutrition status was related to sarcopenia.

Results

Study Population and Characteristics

A total of 81 participants were recruited for this study, including 34 patients who had no sarcopenia and 47 who had possible sarcopenia (Figure 2).

Clinical and demographic characteristics of the study population are detailed in Table 1. In the group of patients without sarcopenia, 55.9% were male; 47.1% lived with their spouse or child; 58.8% and 91.2% took care of themselves and prepared meals by themselves, respectively; and 91.2% performed physical activity. In the group of patients with possible sarcopenia, 63.8% were female, 61.7% lived with their spouse or child, and 55.3% and 89.4% took care of themselves and prepared meals by themselves, respectively. Only 63.8% reported performing physical activity. The mean creatinine level was significantly higher in the group with possible sarcopenia. The mean albumin level was significantly lower in the group with possible sarcopenia. The percentage of participants with low LVEF was not significantly different between the 2 groups, and the majority of both groups were classified as in NYHA functional class III or IV.

Questionnaire Results

The mean score of MNA-SF was higher among participants without sarcopenia than those with possible sarcopenia. There was a statistically significant difference between the 2 groups in the MNA-SF categories. A higher

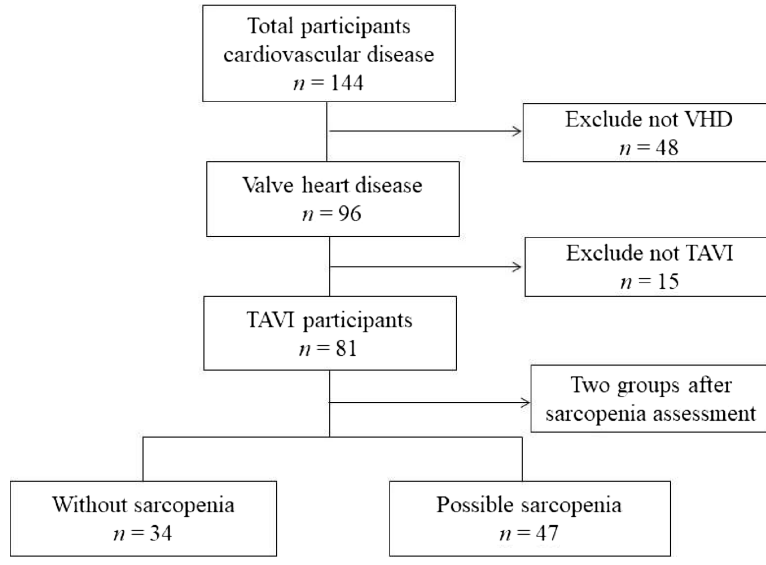

FIGURE 2. *Study flowchart. TAVI, transcatheter aortic valve implantation; VHD, valvular heart disease.*

TABLE 2 Relationships Among Demographics, Nutrition Status, and Family Support of Participants by Group

Variable	Total (N = 81)	Without Sarcopenia (n = 34)	Possible Sarcopenia (n = 47)	MNA-SF			
				Z/χ^2	*P*	*Z*/χ^2	*P*
MNA-SF, mean (SD)	9.9 (1.94)	10.35 (1.82)	9.57 (1.98)	–1.802	.071		
MNA-SF score,[a] n (%)				10.250	.006		
Normal nutrition	6 (7.4)	14 (41.2)	4 (8.5)				
At risk of malnutrition	56 (69.1)	18 (52.9)	38 (80.9)				
Malnutrition	19 (23.5)	2 (5.9)	5 (10.6)				
Family support, mean (SD)	9.21 (1.48)	9.26 (1.46)	9.17 (1.51)	–0.376	.707	0.181	.106
Family support by group, n (%)				0.244	.885	4.568	.102
Minor (1–3)	2 (2.5)	1 (2.9)	1 (2.1)				
Medium (4–7)	6 (7.4)	2 (5.9)	4 (8.5)				
Major (8–10)	73 (90.1)	31 (91.2)	42 (89.4)				

The TAVI possible sarcopenia group has a higher percentage risk of malnutrition; family support was associated with nutrition status.
Abbreviation: MNA-SF, Mini Nutritional Assessment-Short Form.
[a]MNA-SF score: normal nutrition, >12; at risk of malnutrition, 8–11; malnutrition, <7.

percentage of participants with possible sarcopenia was identified as being at risk of malnutrition (Table 2) than those without sarcopenia.

Approximately 90% of the participants indicated that they had high family support, and no significant difference was found between the 2 groups (Table 2). The numerical rating scale scores and categories of family support (minor, medium, and major) were found to be associated with nutritional status ($P = .019$) (Table 3).

Table 4 presents the relationship between caregivers, laboratory results, and nutritional status, as indicated by the MNA-SF scores of all participants. Caregivers ($P = .041$) and albumin ($P = .003$), high-density lipoprotein ($P = .015$), and hemoglobin ($P = .016$) levels showed a statistically significant correlation with MNA-SF scores. However, there was no statistical significance between MNA-SF scores and NYHA cases.

Binary logistic regression analysis with nutritional status (malnutrition vs normal nutrition) as the dependent categorical variable revealed the significant variables of age, physical activity, creatinine and albumin levels, BMI, and family support (Table 5). In steps 1 and 2, malnutrition was negatively associated with higher albumin levels (odds ratios, 0.106 and 0.096, respectively). In step 3, malnutrition was negatively associated with higher albumin levels and possible sarcopenia (odds ratios, 0.082 and 5.549, respectively) after adjusting variables for age, physical activity, creatinine level, BMI, and family support (Table 5).

TABLE 3 Relationship Between Nutrition Status and Family Support

Variable	MNA-SF	Family Support
MNA-SF	1	
Family support	0.260[a]	1

Mini Nutritional Assessment-Short Form (MNA-SF) scores differ significantly according to family support by group.
[a]Correlation is significant at the .05 level (2-tailed), $P = .019$.

Heart Function

The difference in each NYHA functional class and LVEF over time was assessed at 5 time points: baseline (before TAVI; T0); 3 months (T1), 6 months (T2), and 12 months (T3) after TAVI; and beyond 12 months (T4) after TAVI, as shown in Figure 3. The percentages of poor LVEF at baseline were 14.7% and 10.9% in the group without sarcopenia and with possible sarcopenia, respectively. Left ventricular ejection fraction improvement was seen over time. At T3, all of the participants without sarcopenia had LVEF greater than 40%; however, 5% of the participants with possible sarcopenia had LVEF less than 40%.

In addition, the percentage of participants in NYHA functional classes III and IV decreased over time, from approximately greater than 90% to less than 10%, which means that the participants improved in terms of performing physical activity after TAVI. At least 1 functional class improvement of NYHA was shown in the 1-year follow-up. There was no statistically significant

TABLE 4 Demographics Across Nutrition Status of All Participants

Variable	MNA-SF	
	Z/p	*P*
Demographics		
Caregiver	–2.048	.041
Self-care vs care by others		
Medical record		
LVEF (>40% vs <40%)	–0.096	.923
Albumin	0.331	.003
HDL, mg/dL	0.304	.015
Hb	0.270	.016

Mini Nutritional Assessment-Short Form (MNA-SF) scores differ significantly according to caregiver and levels of albumin, high-density lipoprotein, and hemoglobin.
Abbreviations: Hb, hemoglobin; HDL, high-density lipoprotein; LVEF, left ventricular ejection fraction.

TABLE 5 Binary Logistic Regression Model for Predicting Malnutrition Risk

	Step 1				Step 2				Step 3			
Variable	**β**	**OR**	***P***	**95% CI**	**β**	**OR**	***P***	**95% CI**	**β**	**OR**	***P***	**95% CI**
Age	0.011	1.011	.810	0.93–1.11	0.006	1.006	.895	0.92–1.10	−0.035	0.966	.492	0.87–1.06
Physical activity	−1.593	0.203	.189	0.02–2.19	−1.837	0.159	.158	0.01–2.03	−2.014	0.134	.186	0.01–2.64
Creatinine	0.838	2.311	.155	0.73–7.33	0.835	2.306	.161	0.72–7.42	0.838	0.178	.312	0.68–7.84
Albumin	−2.246	0.106	.007	0.02–0.54	−2.343	0.096	.006	0.02–0.52	−2.499	0.082	.015	0.01–0.62
BMI	−0.043	0.958	.642	0.80–1.15	−0.055	0.946	.561	0.79–1.14	−0.043	0.958	.672	0.79–1.17
Family support					−0.684	0.505	.530	0.06–4.27	−1.038	0.354	.363	0.04–3.32
Possible sarcopenia									1.714	5.549	.047	1.02–30.19

Abbreviations: BMI, body mass index; CI, confidence interval; OR, odds ratio.

difference between the groups in terms of LVEF and NYHA functional class at different time points. Compared with that at T0, the improvement in NYHA functional class at T2 was significantly different between the 2 groups ($P = .026$).

Discussion

One of the important findings in this study was that the odds of malnutrition after TAVI were 5.5-fold higher in the group with possible sarcopenia than in the group without sarcopenia. Albumin level was an independent contributor to nutrition, and higher albumin levels improved nutritional status.[20] This finding was consistent with a global study that found that dietary intake, BMI, and albumin and hemoglobin levels were associated with nutritional status in older adults.[14]

Another main finding was that family support was associated with nutrition status in patients who underwent TAVI. Family support is important for aging successfully and has been discussed in previous studies.[11,13,21] Marshall et al[12] observed a significant improvement in nutritional status when family members were included in the care of patients with a critical illness, although a potential barrier for family participation was health literacy. Spouses, children, and specific other family members are the main sources of family support. Spouses can provide care and company during illness and travel for treatment, along with conversation and emotional support, whereas adult children offer mainly financial support.[22] This was consistent with the results of our study and clinical experience, which revealed a relationship between family support and nutritional status Thus, clinicians need to take action to influence the relationship between family support and nutrition to improve health outcomes.

Furthermore, our study found a significant difference in physical activity between the 2 groups and indicated that physical activity was directly related to muscle mass. Physical activity increases appetite and food intake by increasing basal metabolic rate and calorie consumption. Ng et al[23] (2015) conducted a randomized controlled trial to investigate nutritional, physical, and cognitive

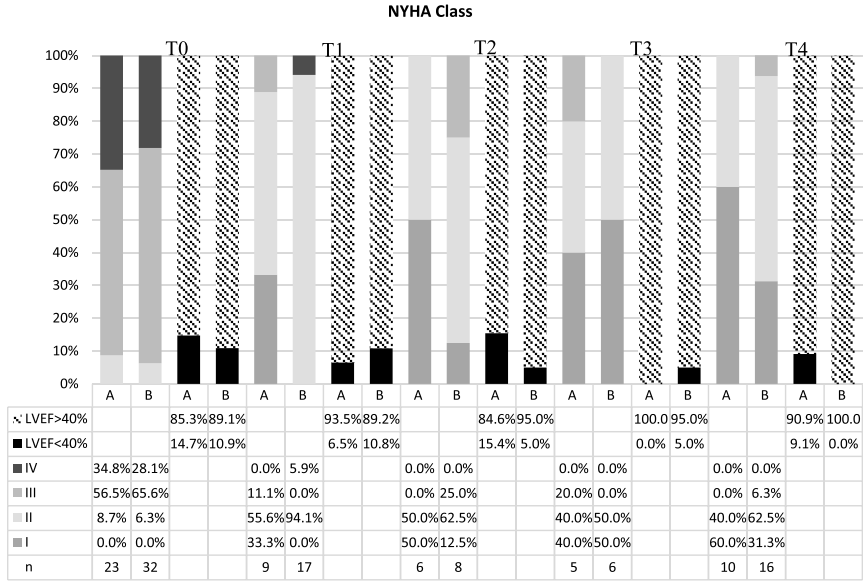

FIGURE 3. *The difference in each NYHA functional class and LVEF heart function over time. A, without sarcopenia; B, possible sarcopenia; T0, baseline: before TAVI; T1, post-TAVI: 3 months; T2, post-TAVI: 6 months; T3, post-TAVI: 12 months; T4, post-TAVI: beyond 12 months.*

What's New and Important

- The risk of malnutrition after TAVI was 5.5-fold higher in the group with possible sarcopenia, and the recommendations are to assess possible sarcopenia in older patients, including measuring grip strength, calf circumference, and walking speed during hospitalization, and to provide nutrition intervention as soon as possible during clinical visits.
- Predictors of malnutrition in older adults who underwent TAVI were albumin level and possible sarcopenia. Thus, further study of the change in nutritional status and biomarkers of albumin, hemoglobin, and creatinine in these older adults can provide valuable information for the field of gerontology.
- The study found that physical activity and family support were associated with nutrition status in patients who underwent TAVI. Therefore, it is essential for the healthcare team to develop appropriate and individual interventions for patients who underwent TAVI to improve their nutrition and physical activity.

factors in older subjects and found physical activity to be positively correlated with weight and albumin level.[24]

In our study, 91.3% and 93.7% of patients were in NYHA classes III and IV, respectively, before TAVI, and among a small sample at follow-up, 60% and 31.3% were in NYHA class I in the groups without sarcopenia and with possible sarcopenia, respectively. With a few exceptions, most patients' NYHA class changed over time, which is consistent with the findings of a previous study.[25]

Our study results showed that age, BMI, and albumin and creatinine levels were different between the groups of participants without sarcopenia and those with possible sarcopenia. Bekfani et al[26] studied 117 patients with heart failure with preserved ejection fraction and found impaired renal function and high creatinine levels to be highly related to sarcopenia development in patients due to the reduction of energy and muscle mass. Loss of energy and muscle mass are often associated with dietary intake decrease, uremic substance accumulation, catabolism hemodialysis, blood hormone imbalance, insulin resistance increase, systemic inflammation, and complications of various complex factors. Moreover, albumin is one indicator of malnutrition.[27,28]

Lai et al[29] noted that, for participants who had a mean age of 74.3 years, low muscle mass was associated with low protein intake, which was reflected in low albumin levels. The relationship between albumin level and nutritional status has been described previously, and creatinine levels have been shown to be negatively associated with nutrition.[30]

Our results also showed that low hemoglobin levels and diagnosed anemia caused a substantial increase in morbidity and mortality and were correlated with nutritional status. This finding is similar to that of a study conducted in Brazil, in which anemia was found to be associated with malnutrition.[31] Alzahrani and Alamri reported that 70% of hospitalized older adult patients were malnourished or at risk of malnutrition, with low levels of albumin and hemoglobin.[32] A systemic review conducted by Torres-de Araújo et al[33] identified factors associated with decreased physical activity and disease progression among older adult patients, including sarcopenia, age increase, sex (female), low family support, and high level of dependence in daily living. The consequences of malnutrition have been investigated in previous research, highlighting that malnutrition increases the incidence of sarcopenia. This is consistent with our finding that possible sarcopenia was related to nutritional status.

In summary, the contributions of this study provide new knowledge about nutritional status and family support in the older groups with possible sarcopenia. Furthermore, it demonstrates changes in heart function over time after undergoing TAVI in this specific population. The results of this study were supported and can be explained by previous research.

Limitations

This study had a number of limitations that need to be acknowledged. First, the study was conducted in a medical hospital in Northern Taiwan, using convenience sampling, with a small sample size. Single-site data collection is a study limitation. Therefore, the results might not apply to other populations. Second, because of limited resources, only self-administered questionnaires were used to assess nutritional status and family support. Finally, only a small proportion of participants' heart function was measured in the long-term follow-up because of missing data. Future studies that involve objective assessments, such as bioelectrical impedance analysis of muscle mass or long-term relationship between heart function and nutrition status, should be included to provide more comprehensive information.

Conclusions

The results indicated that the risk of malnutrition after TAVI was much higher in the group with possible sarcopenia, and predictors of malnutrition in older adults who underwent TAVI were albumin level and diagnosis of sarcopenia. Notably, good family support could help to identify older adult patients who are likely to be malnourished. In addition, low hemoglobin levels are directly related to malnutrition in older adults.

Possible sarcopenia means either low muscle strength or low physical performance. Early screening to identify the risk factors of possible sarcopenia and early lifestyle interventions in diet and exercise are essential for treatment. Malnutrition is the primary cause of possible sarcopenia, and this study found that the risk of malnutrition was 5.5-fold higher in patients with possible sarcopenia. Malnutrition was associated with many negative health

outcomes in older adult patients, the most important of which was the decline in physical activity and quality of life. The results of this study provide valuable information for patients with possible sarcopenia who underwent TAVI.

REFERENCES

1. Yin WH. Transcatheter aortic valve implantation in Taiwan: still evolving! *Acta Cardiol Sin*. 2017;33:350–352.
2. Fattouch K, Castrovinci S, Carità P. Aortic valve stenosis: treatments options in elderly high-risk patients. *J Geriatr Cardiol*. 2016;13(6):473–474.
3. Liguori I, Russo G, Aran L, et al. Sarcopenia: assessment of disease burden and strategies to improve outcomes. *Clin Interv Aging*. 2018;13:913–927.
4. Cruz-Jentoft AJ, Bahat G, Bauer J, et al. Sarcopenia: revised European consensus on definition and diagnosis. *Age Ageing*. 2019;48(1):16–31. doi:10.1093/ageing/afy169.
5. Chen LK, Woo J, Assantachai P, et al. Asian working group for sarcopenia: 2019 consensus update on sarcopenia diagnosis and treatment. *J Am Med Dir Assoc*. 2020;21(3):300–307.e2. doi:10.1016/j.jamda.2019.12.012.
6. Wu YJ, Chou YC, Chan DC. Review: sarcopenia and frailty. *J Intern Med Taiwan*. 2014;25:131–136. doi:10.6314/JIMT.2014.25(3).01.
7. Ibrahim K, Howson FFA, Culliford DJ, et al. The feasibility of assessing frailty and sarcopenia in hospitalised older people: a comparison of commonly used tools. *BMC Geriatr*. 2019;19:42. doi:10.1186/s12877-019-1053-y.
8. Lim HS, Lee MN. Comparison of health status and nutrient intake by household type in the elderly population. *J Bone Metab*. 2019;26(1):25–30.
9. Baek YJ, Paik HY, Shim JE. Association between family structure and food group intake in children. *Nutr Res Pract*. 2014;8(4):463–468.
10. Chiang HH, Chien LH, Lin JS, et al. Modeling psychological well-being and family relationships among retired older people in Taiwan. *Int J Ment Health Nurs*. 2013;22(1):93–101.
11. Thanakwang K. Family support, anticipated support, negative interaction, and psychological well-being of older parents in Thailand. *Psychogeriatrics*. 2015;15(3):171–178.
12. Marshall AP, Lemieux M, Dhaliwal R, et al. Novel, family-centered intervention to improve nutrition in patients recovering from critical illness: a feasibility study. *Nutr Clin Pract*. 2017;32(3):392–399.
13. Marshall S, Agarwal E, Young A, et al. Role of domiciliary and family carers in individualised nutrition support for older adults living in the community. *Maturitas*. 2017;98:20–29.
14. Saghafi-Asl M, Vaghef-Mehrabany E. Comprehensive comparison of malnutrition and its associated factors between nursing home and community dwelling elderly: a case-control study from Northwestern Iran. *Clin Nutr ESPEN*. 2017;21:51–58.
15. Rubenstein LZ, Harker JO, Salvà A, et al. Screening for undernutrition in geriatric practice: developing the Short-Form Mini-Nutritional Assessment (MNA-SF). *J Gerontol A Biol Sci Med Sci*. 2001;56(6):M366–M372.
16. Chien YW, Huang MC, Liao FH, et al. The new model for assessing nutritional status in hospital in-patients. *Nutr Soc J*. 2003;28(4):200–209.
17. Bleda MJ, Bolibar I, Parés R, et al. Reliability of the Mini Nutritional Assessment (MNA) in institutionalized elderly people. *J Nutr Health Aging*. 2002;6(2):134–137.
18. Kaiser MJ, Bauer JM, Ramsch C, et al. Validation of the Mini Nutritional Assessment Short-Form (MNA-SF): a practical tool for identification of nutritional status. *J Nutr Health Aging*. 2009;13:782–788.
19. Wu YY. *Numerical rating scale*. National Academy for Education Research; 2000. http://terms.naer.edu.tw/detail/1313798/. Accessed April 30, 2018.
20. Sousa NDS, Menezes TN, Silva NA, et al. Prevalence of anemia and correlation between the concentration of hemoglobin and cognitive factors among the elderly. *Cien Saude Colet*. 2018;23(3):935–944.
21. Vedanthan R, Bansilal S, Soto AV, et al. Family-based approaches to cardiovascular health promotion. *J Am Coll Cardiol*. 2016;67(14):1725–1737.
22. Lee CF, Tang SM. Gender differences in the inter-relationships among health condition, gender-pattern housework, and life satisfaction in middle-aged and older adults. *Taiwan J Public Health*. 2017;36(5):461–472.
23. Ng TP, Feng L, Nyunt MS, et al. Nutritional, physical, cognitive, and combination interventions and frailty reversal among older adults: a randomized controlled trial. *Am J Med*. 2015;128(11):1225–1236.e1.
24. Luger E, Dorner TE, Haider S, et al. Effects of a home-based and volunteer-administered physical training, nutritional, and social support program on malnutrition and frailty in older persons: a randomized controlled trial. *J Am Med Dir Assoc*. 2016;17(7):671.e9–671.e16. doi:10.1016/j.jamda.2016.04.018.
25. Muratori M, Fusini L, Tamborini G, et al. Sustained favourable haemodynamics 1 year after TAVI: improvement in NYHA functional class related to improvement of left ventricular diastolic function. *Eur Heart J Cardiovasc Imaging*. 2016;17(11):1269–1278. doi:10.1093/ehjci/jev306.
26. Bekfani T, Pellicori P, Morris DA, et al. Sarcopenia in patients with heart failure with preserved ejection fraction: impact on muscle strength, exercise capacity and quality of life. *Int J Cardiol*. 2016;222:41–46. doi:10.1016/j.ijcard.2016.07.135.
27. Canteri AL, Gusmon LB, Zanini AC, et al. Sarcopenia in heart failure with reduced ejection fraction. *Am J Cardiovasc Dis*. 2019;9(6):116–126.
28. Kamijo Y, Kanda E, Ishibashi Y, Yoshida M. Sarcopenia and frailty in PD: impact on mortality, malnutrition, and inflammation. *Perit Dial Int*. 2018;38(6):447–454. doi:10.3747/pdi.2017.00271.
29. Lai FY, Chang HY, Lee MC, et al. Association of protein intake and low muscle mass in elderly people in Taiwan. *Taiwan Geriatr Gerontol*. 2017;12(3):191–206.
30. Lim PS, Liu PH, Kuo FC, et al. Metabolic syndrome and renal function of the chronic kidney disease patients. *Nutr Sci J*. 2015;40:122–135.
31. Alzahrani SH, Alamri SH. Prevalence of malnutrition and associated factors among hospitalized elderly patients in King Abdulaziz University Hospital, Jeddah, Saudi Arabia. *BMC Geriatr*. 2017;17(1):136.
32. Zhang Z, Pereira SL, Luo M, et al. Evaluation of blood biomarkers associated with risk of malnutrition in older adults: a systematic review and meta-analysis. *Nutrients*. 2017;9(8):829. doi:10.3390/nu9080829.
33. Torres-de Araújo JR, Tomaz-de Lima RR, Ferreira-Bendassolli IM, et al. Functional, nutritional and social factors associated with mobility limitations in the elderly: a systematic review. *Salud Publica Mex*. 2018;60(5):579–585.