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IMPACT OF BODY MASS INDEX ON ACTIVITIES OF DAILY LIVING IN INPATIENTS WITH ACUTE HEART FAILURE

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Abstract: *Objectives:* To investigate the impact of body mass index on activities of daily living in inpatients with acute heart failure. *Design:* A retrospective cohort study. *Setting:* A hospital-based database contains Diagnosis Procedure Combination survey data from 100 participating acute-care hospitals. *Participants:* 11,301 inpatients aged 20 year or older who were admitted to the participating hospitals with a diagnosis of acute heart failure. *Measurements:* The Barthel Index score at discharge and hospital death. *Results:* The number of patients with a body mass index of <18.5 kg/m^2 (underweight), 18.5–22.9 kg/m^2 (low–normal weight), 23.0–24.9 kg/m^2 (high–normal weight), 25.0–29.9 kg/m^2 (overweight), and ≥30.0 kg/m^2 (obesity) were 1689 (15%), 4715 (42%), 1809 (16%), 2306 (20%), and 782 (7%), respectively. Median Barthel Index scores at admission and discharge were 65 and 100, respectively. Hospital death occurred in 101 (0.9%) patients. Lower body mass index was associated with lower Barthel Index score at discharge and higher mortality. Multivariable analysis adjusted for body mass index, age, sex, New York Heart Association classification, Barthel Index score at admission, the updated Charlson Comorbidity Index, length of hospital stay, number of drugs administered, and rehabilitation during hospitalization revealed that body mass index was independently associated with Barthel Index score at discharge (beta: 0.354; 95% confidence interval: 0.248–0.461) and hospital death (odds ratio: 0.926, 95% confidence interval: 0.877–0.978). *Conclusion:* Overweight and obese inpatients showed greater independence in activities of daily living at discharge and lower rates of mortality, indicating the obesity paradox. A combination of rehabilitation and improved nutrition seems to be important in underweight patients with acute heart failure.

Keywords: Cardiac rehabilitation, malnutrition, mortality, obesity paradox, overweight.

Introduction

Malnutrition is common and can lead to poor outcomes in patients with acute heart failure. In inpatients with acute heart failure, 23.1% are malnourished and 51.9% are at risk of malnutrition (1). Another study shows that, among patients with advanced heart failure, 24.7% are classified as malnourished and 65.4% are classified as at risk of malnutrition (2). Malnutrition is associated with readmission due to worsening heart failure and increased mortality (1, 2). Furthermore, the Prognostic Nutritional Index calculated by 10 × serum albumin (g/dL) + 0.005 × total lymphocyte count (/mm^3) is independently associated with long-term survival in inpatients with acute heart failure (3). Therefore, nutritional status and nutrition management are very important in acute heart failure. We reported a case showing that malnutrition, sarcopenia, and cachexia can be present in acute heart failure, and a combination of rehabilitation and nutrition care management may be useful for treating these conditions (4).

Nutritional status affects rehabilitation outcomes in some diseases, although the relationship between them in acute heart failure is unknown. We have previously reported that obese patients have higher functional recovery among convalescent rehabilitation stroke patients (5). Higher BMI and pre-fracture malnutrition are associated with poorer functional recovery in patients with hip fracture (6, 7). Malnutrition is associated with low physical function in patients with chronic obstructive pulmonary disease undergoing pulmonary rehabilitation (8) and those undergoing rehabilitation for hospital-associated deconditioning (9). These results indicate an association between nutritional status and rehabilitation outcome; however, this association has not been verified in acute heart failure. Furthermore, the obesity paradox in acute heart failure patients remains controversial (10-16), although no studies have evaluated the relationship between obesity and rehabilitation outcome. Thus, it is not known whether the obesity paradox occurs in rehabilitation outcome in patients with acute heart failure.

The purpose of this study was therefore to investigate the impact of body mass index on the activities of daily living in inpatients with acute heart failure.

Methods

We performed a retrospective cohort study using a hospital-based database constructed by the Japan Medical Data Center (JMDC). As of 2017, the database contains Diagnosis Procedure Combination (DPC) survey data of approximately 3 million from 100 participating acute-care hospitals across Japan. To enable use of the database for research purposes,

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a secondary database is generated by linking files via anonymous identifiers. We extracted data on consecutive inpatients admitted with acute heart failure from April 2014 to November 2017 from the JMDC DPC survey data. Specialized rehabilitation hospitals were not included. Administrative claims data and some detailed clinical data were collected for all inpatients discharged from the participating hospitals. The database includes hospitals' unique identifiers and the following patient data: age; sex; diagnosis and comorbidities recorded with text data in Japanese and the International Statistical Classification of Diseases, 10th Revision codes; number of drugs administered at admission; length of hospital stay; and presence or absence of rehabilitation during hospitalization. All diagnoses and comorbidities were recorded by the attending physicians. The database also includes severity of heart failure assessed using the New York Heart Association (NYHA) classification (17).

Because of the anonymous nature of the data, the requirement for informed consent and approval was waived. Analysis of the JMDC database was approved by the Institutional Review Board of Teikyo University. The study was performed in accordance with the ethical standards of the 1964 Declaration of Helsinki and its later amendments.

We identified inpatients aged 20 year or older who were admitted to the participating hospitals with a diagnosis of acute heart failure (International Statistical Classification of Diseases, 10th Revision, code I50). We excluded inpatients with missing values for NYHA classification, body mass index, and/or Barthel index score (18).

Body mass index categories at admission were assigned based on the modified World Health Organization classifications of <18.5 kg/m^2 (underweight), 18.5–22.9 kg/m^2 (low–normal weight), 23.0–24.9 kg/m^2 (high-normal weight), 25.0–29.9 kg/m^2 (overweight), and ≥30.0 kg/m^2 (obesity) (19). Rehabilitation outcome was defined as activities of daily living at discharge, which were assessed using the Barthel Index. The Barthel Index consists of the following 10 items: 1) feeding, 2) moving back and forth between a wheelchair and bed, 3) grooming, 4) using a toilet, 5) bathing, 6) walking on a level surface, 7) moving up and down stairs, 8) dressing, 9) bowel continence, and 10) bladder continence (18). The main outcomes were Barthel Index score at discharge. Barthel Index gain was calculated as Barthel Index score at discharge minus Barthel Index score at admission.

Comorbidities were evaluated using the updated Charlson Comorbidity Index (20) using the International Statistical Classification of Diseases, 10th Revision codes. The maximum comorbidity score of the updated Charlson Comorbidity Index is 24 points, and includes congestive heart failure (2 points), dementia (2 points), chronic pulmonary disease (1 point), rheumatologic disease (1 point), mild liver disease (2 points), diabetes with chronic complications (1 point), hemiplegia or paraplegia (2 points), renal disease (1 point), any malignancy including leukemia and lymphoma (2 points), moderate or severe liver disease (4 points), metastatic solid tumor (6 points), and AIDS/human immunodeficiency virus infection (4 points). The presence of rehabilitation during hospitalization was defined as physical therapy performed at least once. The number of drugs administered on admission was collected from the DPC data because polypharmacy may affect activities of daily living (21).

The IBM Statistical Package for the Social Sciences (SPSS) version 25 software (IBM Corporation; Armonk, NY, USA) was used for statistical analyses. Parametric data are presented as means ± standard deviations and nonparametric data as medians and interquartile ranges. The chi-square test, Kruskal-Wallis test, and Bonferroni multiple comparisons test were performed to analyze differences between body mass index categories. Spearman rank correlation was calculated to analyze relationships between body mass index, the Barthel Index, length of hospital stay, and number of drugs administered. Multiple regression analysis was conducted to examine whether body mass index was independently associated with Barthel Index score at discharge. Logistic regression analysis was conducted to examine whether body mass index was independently associated with hospital death. The independent variables were age, sex, NYHA classification, Barthel Index score at admission, the updated Charlson Comorbidity Index, length of hospital stay, number of drugs administered on admission, and the presence or absence of rehabilitation during hospitalization. The Mann-Whitney U test was used to analyze differences between the presence or absence of rehabilitation during hospitalization. A p-value < 0.05 was determined statistically significant.

Results

A total of 28,920 inpatients with acute heart failure on admission were identified in the JMDC DPC database during the study period. We excluded 8 patients less than 20 years old and 17,611 patients with missing values. Thus, we analyzed 11,301 patients with acute heart failure in this study.

Table 1 summarizes the patients' characteristics. The number of patients who were underweight, low-normal weight, high-normal weight, overweight, and obese were 1689 (15%), 4715 (42%), 1809 (16%), 2306 (20%), and 782 (7%), respectively. Median Barthel Index scores at admission and discharge were 65 (interquartile range: 15–100) and 100 (interquartile range: 60–100), respectively. Barthel Index gain during hospitalization was negative in 781 (7%) inpatients. Median Barthel Index scores at discharge were significantly different between body mass index categories. In a Bonferroni multiple comparison test, the Barthel Index score at discharge was significantly lower in the underweight group than in the other four groups (all $p<0.001$). The Barthel Index score at discharge was significantly lower in the low-normal weight group than in the high-normal weight, overweight, and obesity groups (all $p<0.001$). The Barthel Index score at discharge

Table 1
Inpatient characteristics

	Total N=11301	Underweight N=1689	Low-normal weight N=4715	High- normal weight N=1809	Overweight N=2306	Obesity N=782	P value
Age (years)							<0.001[1)]
20-64	1332 (12%)	79 (5%)	346 (7%)	196 (11%)	397 (17%)	314 (40%)	
65-74	1959 (17%)	201 (12%)	776 (16%)	381 (21%)	458 (20%)	143 (18%)	
75-84	3754 (33%)	480 (28%)	1564 (33%)	647 (36%)	849 (37%)	214 (27%)	
≥ 85	4256 (38%)	929 (55%)	2029 (43%)	585 (32%)	602 (26%)	111 (14%)	
Sex							<0.001[1)]
Male	5910 (52%)	636 (38%)	2418 (51%)	1048 (58%)	1394 (60%)	414 (53%)	
Female	5391 (48%)	1053 (62%)	2297 (49%)	761 (42%)	912 (40%)	368 (47%)	
NYHA classification							0.043[1)]
1	812 (7%)	99 (6%)	350 (7%)	129 (7%)	184 (8%)	50 (6%)	
2	3327 (29%)	484 (29%)	1413 (30%)	527 (29%)	676 (29%)	227 (29%)	
3	4386 (39%)	637 (38%)	1793 (38%)	733 (41%)	901 (39%)	322 (41%)	
4	2776 (25%)	469 (28%)	1159 (25%)	420 (23%)	545 (24%)	183 (23%)	
Barthel Index score at admission	65 (15–100)	40 (0–95)	60 (10–100)	80 (30–100)	80 (39–100)	90 (45–100)	<0.001[2)]
Barthel Index score at discharge	100 (60–100)	80 (30–100)	100 (55–100)	100 (75–100)	100 (80–100)	100 (90–100)	<0.001[2)]
Barthel Index gain							0.007[1)]
< 0	781 (7%)	146 (9%)	325 (7%)	125 (7%)	147 (6%)	38 (5%)	
≥ 0	10520 (93%)	1543 (91%)	4390 (93%)	1684 (93%)	2159 (94%)	744 (95%)	
Charlson Comorbidity Index update	0 (0–1)	0 (0–1)	0 (0–1)	0 (0–1)	0 (0–1)	0 (0–1)	0.293[1)]
Length of hospital stay	18 (11–29)	20 (13–34)	18 (12–29)	17 (11–27)	17 (11–26)	17 (11–25)	<0.001[2)]
Number of drugs administered on admission	10 (7–13)	9 (6–13)	10 (7–13)	10 (7–14)	10 (7–14)	11 (7–14)	<0.001[2)]
Rehabilitation during hospitalization							<0.001[1)]
Yes	5353 (47%)	933 (55%)	2292 (49%)	792 (44%)	995 (43%)	341 (44%)	
No	5948 (53%)	756 (45%)	2423 (51%)	1017 (56%)	1311 (57%)	441 (56%)	
Hospital death							<0.001[1)]
Yes	101 (0.9%)	30 (1.8%)	46 (1.0%)	12 (0.7%)	10 (0.4%)	3 (0.4%)	
No	11200 (99.1%)	1659 (98.2%)	4669 (99.0%)	1797 (99.3%)	2296 (99.6%)	779 (99.6%)	

NYHA: New York Heart Association; 1) Chi-square test, 2) Kruskal-Wallis test

Table 2
Spearman rank correlation coefficients between, body mass index, Barthel Index score, length of hospital stay, and number of drugs administered on admission

	Barthel Index score at admission	Barthel Index score at discharge	Length of hospital stay	Number of drugs administered on admission
Body mass index	0.173*	0.215*	-0.082*	0.054*
Barthel Index score at admission		0.602*	-0.226*	-0.046*
Barthel Index score at discharge			-0.249*	-0.022*
Length of hospital stay				0.423*

* means P value < 0.05

was significantly lower in the high-normal weight group than in the obesity group (p=0.001). There was no statistically significant difference in Barthel Index scores at discharge between the overweight and obesity groups (p=0.180). Hospital death occurred in 101 (0.9%) inpatients. Underweight patients had higher mortality rates than overweight and obese patients (p<0.001).

Table 2 shows Spearman rank correlation coefficients between body mass index, Barthel Index score, length of hospital stay, and number of drugs administered. Body mass index correlated significantly with Barthel Index scores at both admission and discharge.

Table 3
Multiple regression analysis of Barthel Index score at discharge

	Unstandardized coefficient				Standardized	P-value
	β	standard error	95% CI of β		coefficient	
Body mass index	0.354	0.054	0.248	0.461	0.050	<0.001
Age	-0.428	0.022	-0.472	-0.385	-0.156	<0.001
Sex	4.600	0.497	3.626	5.574	0.070	<0.001
NYHA classification	0.277	0.280	-0.271	0.826	0.008	0.322
Barthel Index score at admission	0.422	0.007	0.409	0.435	0.514	<0.001
Charlson Comorbidity Index update	-1.015	0.215	-1.438	-0.593	-0.034	<0.001
Length of hospital stay	-0.117	0.008	-0.132	-0.102	-0.118	<0.001
Number of drugs administered on admission	0.295	0.047	0.204	0.387	0.049	<0.001
Rehabilitation during hospitalization	-0.429	0.510	-1.430	0.571	-0.007	0.400
Constant	75.549	2.704	70.248	80.849		<0.001

CI: confidence interval

Table 4
Relationship between the Barthel Index and rehabilitation during hospitalization

	Presence of rehabilitation	Absence of rehabilitation	P-value
Barthel Index score at admission	50 (5–100)	90(50–100)	<0.001
Barthel Index score at discharge	90 (50–100)	100 (80–100)	<0.001
Barthel Index gain	5 (0–45)	0 (0–25)	<0.001

Mann-Whitney U test

Table 3 shows multiple regression analysis of the Barthel Index score at discharge. Body mass index was independently associated with Barthel Index score at discharge after adjusting for age, sex, NYHA classification, Barthel Index score at admission, updated Charlson Comorbidity Index, length of hospital stay, number of drugs administered on admission, and presence or absence of rehabilitation during hospitalization. In contrast, rehabilitation during hospitalization was not independently associated with the Barthel Index score at discharge. However, the Barthel Index gain was significantly higher in inpatients performing rehabilitation during hospitalization, although the Barthel Index scores at admission and discharge were significantly lower (Table 4).

Table 5 shows logistic regression analysis of hospital deaths. Body mass index was independently associated with hospital death after adjusting for age, sex, NYHA classification, Barthel Index score at admission, the updated Charlson Comorbidity Index, length of hospital stay, number of drugs administered on admission, and the presence or absence of rehabilitation during hospitalization. Furthermore, rehabilitation during hospitalization was independently associated with low incidence of hospital death.

Discussion

We investigated the impact of body mass index on activities of daily living in inpatients with acute heart failure. Underweight patients with acute heart failure showed lower independence in activities of daily living at discharge. Overweight and obese patients showed higher independence in activities of daily living at discharge and lower mortality, indicating the obesity paradox.

Underweight inpatients with acute heart failure showed lower independence in activities of daily living at discharge. Underweight patients with heart failure were likely to have sarcopenia and cachexia. The prevalence of sarcopenia in acute decompensated heart failure is 52.6%, and sarcopenia is associated with increased disease severity (22). Cardiac cachexia can occur in patients with acute heart failure (4), and the prevalence of cachexia in advanced heart failure is 5–15% (23). Sarcopenia and cachexia worsen skeletal muscle function and performance in patients with heart failure (23). Therefore, in the assessment and improvement of nutrition it is important to treat malnutrition, sarcopenia, cachexia, and activities of daily living in patients with acute heart failure.

Overweight and obese inpatients with acute heart failure showed higher independence in activities of daily living at discharge as well as lower mortality rates, indicating the obesity paradox. In a meta-analysis, overweight and obesity were associated with lower mortality rates in patients with heart failure (24). Overweight and obese patients are likely to have higher muscle mass compared with underweight patients (25). Higher muscle mass in overweight and obese patients may allow greater independence in activities of daily living. Therefore, weight loss in overweight and obese patients with acute heart failure may not be favorable except for reducing edema and/or pleural effusion as a result of diuretic therapy. Since this study did not investigate weight change during

Table 5
Logistic regression analysis of hospital death at discharge

	β	Standard error	Odds ratio	95% CI of odds ratio		P-value
Body mass index	-0.077	0.028	0.926	0.877	0.978	0.005
Age	0.039	0.013	1.039	1.013	1.067	0.003
Sex	-0.282	0.223	0.754	0.487	1.169	0.207
NYHA classification	0.440	0.130	1.553	1.203	2.004	0.001
Barthel Index score at admission	-0.011	0.003	0.989	0.983	0.995	<0.001
Charlson Comorbidity Index update	0.153	0.077	1.165	1.001	1.356	0.048
Length of hospital stay	0.001	0.001	1.001	1.000	1.003	0.142
Number of drugs administered on admission	-0.003	0.020	0.997	0.958	1.037	0.871
Rehabilitation during hospitalization	-0.715	0.217	0.489	0.320	0.748	0.001
Constant	-6.648	1.440	0.001			<0.001

CI: confidence interval

hospital stay, further studies will be required to examine the effect of weight change on rehabilitation outcome in acute heart failure.

Both cardiac rehabilitation and nutrition management are important in acute heart failure, although rehabilitation during hospitalization was not independently associated with the Barthel Index score at discharge. Cardiac rehabilitation tends to be prescribed for patients with low independence in activities of daily living. Indeed, the Barthel Index scores on admission and discharge were significantly lower in patients undergoing rehabilitation during hospitalization; however, the Barthel Index gain was significantly higher in these patients. Therefore, cardiac rehabilitation should be prescribed for acute heart failure, although it has been underused in Japan (26). Indeed, rehabilitation during hospitalization was independently associated with low rates of hospital death in this study. Therefore, a combination of rehabilitation and improved nutrition seems to be important for underweight patients with acute heart failure.

This study has a few limitations. First, more than half of the inpatients were excluded from the analysis due to missing values. Second, the JMDC DPC database lacks detailed information in some areas. Sarcopenia, cachexia, contents of rehabilitation, and severity of heart failure, other than NYHA classification, were not evaluated in this study. Further studies are necessary to clarify the association between sarcopenia, cachexia, and rehabilitation outcome in acute heart failure.

In conclusion, underweight inpatients with acute heart failure showed lower independence in activities of daily living at discharge. Overweight and obese inpatients showed higher independence of activities of daily living at discharge and lower mortality rates, indicating the obesity paradox. A combination of rehabilitation and improved nutrition seems to be important in underweight patients with acute heart failure.

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References

1. Suzuki N, Kida K, Suzuki K, Harada T, Akashi YJ. Assessment of transthyretin combined with mini nutritional assessment on admission provides useful prognostic information in patients with acute decompensated heart failure. Int Heart J. 2015;56:226-233. doi: 10.1536/ihj.14-255.
2. Yost G, Gregory M, Bhat G. Short-form nutrition assessment in patients with advanced heart failure evaluated for ventricular assist device placement or cardiac transplantation. Nutr Clin Pract. 2014;29:686-691. doi: 10.1177/0884533614535269.
3. Cheng YL, Sung SH, Cheng HM, Hsu PF, Guo CY, Yu WC, Chen CH. Prognostic Nutritional Index and the Risk of Mortality in Patients With Acute Heart Failure. J Am Heart Assoc. 2017;6:e004876. doi: 10.1161/JAHA.116.004876.
4. Someya R, Wakabayashi H, Hayashi K, Akiyama E, Kimura K. Rehabilitation Nutrition for Acute Heart Failure on Inotropes with Malnutrition, Sarcopenia, and Cachexia: A Case Report. J Acad Nutr Diet. 2016;116:765-768. doi: 10.1016/j.jand.2015.11.002.
5. Nishioka S, Wakabayashi H, Yoshida T, Mori N, Watanabe R, Nishioka E. Obese Japanese Patients with Stroke Have Higher Functional Recovery in Convalescent Rehabilitation Wards: A Retrospective Cohort Study. J Stroke Cerebrovasc Dis. 2016;25:26-33. doi: 10.1016/j.jstrokecerebrovasdis.2015.08.029.
6. Di Monaco M, Vallero F, Di Monaco R, Mautino F, Cavanna A. Body mass index and functional recovery after hip fracture: a survey study of 510 women. Aging Clin Exp Res.2006;18:57-62.
7. Inoue T, Misu S, Tanaka T, Sakamoto H, Iwata K, Chuman Y, Ono R. Pre-fracture nutritional status is predictive of functional status at discharge during the acute phase with hip fracture patients: A multicenter prospective cohort study. Clin Nutr. 2017;36:1320-1325. doi: 10.1016/j.clnu.2016.08.021.
8. Gunay E, Kaymaz D, Selcuk NT, Ergun P, Sengul F, Demir N. Effect of nutritional status in individuals with chronic obstructive pulmonary disease undergoing pulmonary rehabilitation. Respirology. 2013;18:1217-1222. doi: 10.1111/resp.12133.
9. Wakabayashi H, Sashika H. Malnutrition is associated with poor rehabilitation outcome in elderly inpatients with hospital-associated deconditioning a prospective cohort study. J Rehabil Med. 2014;46:277-282. doi: 10.2340/16501977-1258.
10. Adamopoulos C, Meyer P, Desai RV, Karatzidou K, Ovalle F, White M, Aban I, Love TE, Deedwania P, Anker SD, Ahmed A. Absence of obesity paradox in patients with chronic heart failure and diabetes mellitus: a propensity-matched study. Eur J Heart Fail. 2011;13:200-206. doi: 10.1093/eurjhf/hfq159.
11. Zamora E, Lupon J, Enjuanes C, Pascual-Figal D, de Antonio M, Domingo M, Comin-Colet J, Vila J, Penafiel J, Farre N, Alonso N, Santesmases J, Troya M, Bayes-Genis A. No benefit from the obesity paradox for diabetic patients with heart failure. Eur J Heart Fail. 2016;18:851-858. doi: 10.1002/ejhf.576.
12. Matsushita M, Shirakabe A, Hata N, Shinada T, Kobayashi N, Tomita K, Tsurumi M, Okazaki H, Yamamoto Y, Asai K, Shimizu W. Association between the body mass index and the clinical findings in patients with acute heart failure: evaluation of the

obesity paradox in patients with severely decompensated acute heart failure. Heart Vessels. 2017;32:600-608. doi: 10.1007/s00380-016-0908-9.
13. Charnigo R, Guglin M. Obesity paradox in heart failure: statistical artifact, or impetus to rethink clinical practice? Heart Fail Rev. 2017;22:13-23. doi: 10.1007/s10741-016-9577-0.
14. Shah R, Gayat E, Januzzi JL, Jr., Sato N, Cohen-Solal A, diSomma S, Fairman E, Harjola VP, Ishihara S, Lassus J, Maggioni A, Metra M, Mueller C, Mueller T, Parenica J, Pascual-Figal D, Peacock WF, Spinar J, van Kimmenade R, Mebazaa A. Body mass index and mortality in acutely decompensated heart failure across the world: a global obesity paradox. J Am Coll Cardiol. 2014;63:778-785. doi: 10.1016/j.jacc.2013.09.072.
15. Littnerova S, Parenica J, Spinar J, Vitovec J, Linhart A, Widimsky P, Jarkovsky J, Miklik R, Spinarova L, Zeman K, Belohlavek J, Malek F, Felsoci M, Kettner J, Ostadal P, Cihalik C, Spac J, Al-Hiti H, Fedorco M, Fojt R, Kruger A, Malek J, Mikusova T, Monhart Z, Bohacova S, Pohludkova L, Rohac F, Vaclavik J, Vondrakova D, Vyskocilova K, Bambuch M, Dusek L. Positive influence of being overweight/obese on long term survival in patients hospitalised due to acute heart failure. PLoS One. 2015;10:e0117142. doi: 10.1371/journal.pone.0117142.
16. Wleklik M, Uchmanowicz I, Jankowska-Polańska B, Andreae C, Regulska-Ilow B. The Role of Nutritional Status in Elderly Patients with Heart Failure. J Nutr Health Aging. 2018;22:581-588. doi: 10.1007/s12603-017-0985-1.
17. Fleg JL, Pina IL, Balady GJ, Chaitman BR, Fletcher B, Lavie C, Limacher MC, Stein RA, Williams M, Bazzarre T. Assessment of functional capacity in clinical and research applications: An advisory from the Committee on Exercise, Rehabilitation, and Prevention, Council on Clinical Cardiology, American Heart Association. Circulation. 2000;102:1591-1597.
18. Mahoney FI, Barthel DW. Functional evaluation: the Barthel index. Md State Med J. 1965;14:61-65.
19. Yamauchi Y, Hasegawa W, Yasunaga H, Sunohara M, Jo T, Takami K, Matsui H, Fushimi K, Nagase T. Paradoxical association between body mass index and in-hospital mortality in elderly patients with chronic obstructive pulmonary disease in Japan. Int J Chron Obstruct Pulmon Dis. 2014;9:1337-1346. doi: 10.2147/COPD.S75175.
20. Quan H, Li B, Couris CM, Fushimi K, Graham P, Hider P, Januel JM, Sundararajan V. Updating and validating the Charlson comorbidity index and score for risk adjustment in hospital discharge abstracts using data from 6 countries. Am J Epidemiol. 2011;173:676-682. doi: 10.1093/aje/kwq433.
21. Kose E, Maruyama R, Okazoe S, Hayashi H. Impact of Polypharmacy on the Rehabilitation Outcome of Japanese Stroke Patients in the Convalescent Rehabilitation Ward. J Aging Res. 2016;2016:7957825.
22. Tsuchida K, Fujihara Y, Hiroki J, Hakamata T, Sakai R, Nishida K, Sudo K, Tanaka K, Hosaka Y, Takahashi K, Oda H. Significance of Sarcopenia Evaluation in Acute Decompensated Heart Failure. Int Heart J. 2018;59:143-148. doi: 10.1536/ihj.17-057.
23. Saitoh M, Ishida J, Doehner W, von Haehling S, Anker MS, Coats AJS, Anker SD, Springer J. Sarcopenia, cachexia, and muscle performance in heart failure: Review update 2016. Int J Cardiol. 2017;238:5-11. doi: 10.1016/j.ijcard.2017.03.155.
24. Oreopoulos A, Padwal R, Kalantar-Zadeh K, Fonarow GC, Norris CM, McAlister FA. Body mass index and mortality in heart failure: a meta-analysis. Am Heart J. 2008;156:13-22. doi: 10.1016/j.ahj.2008.02.014.
25. Yu R, Wong M, Leung J, Lee J, Auyeung TW, Woo J. Incidence, reversibility, risk factors and the protective effect of high body mass index against sarcopenia in community-dwelling older Chinese adults. Geriatr Gerontol Int. 2014;14 Suppl 1:15-28. doi: 10.1111/ggi.12220.
26. Kanazawa N, Ueshima K, Tominari S, Nakayama T. Underuse of Cardiac Rehabilitation in Workers With Coronary Artery Disease- Claims Database Survey in Japan. Circ J. 2017;81:1424-1431. doi: 10.1253/circj.CJ-16-1260.