International Journal of Gerontology 13 (2019) 129–133
https://doi.org/10.6890/IJGE.201906_13(2).0006

International Journal of Gerontology

journal homepage: http://www.sgecm.org.tw/ijge/

Original Article

Dynapenia and Poor Balance Predict Post-Discharge Functional Decline and Mortality of Older Adults

Lingyan Chen [a #], Wei-Ju Lee [b,c,d #], Ying Xu [a], Gaobo Lou [a], Shanshan Shen [e], Ming-Yueh Chou [b,f], Xujiao Chen [e *], Liang-Kung Chen [b,c,g *]

[a] *Department of Nursing, Zhejiang Hospital, Hangzhou, Zhejiang Province, People's Republic of China,* [b] *Aging and Health Research Center, National Yang Ming University, Taipei, Taiwan,* [c] *Department of Geriatric Medicine, School of Medicine, National Yang Ming University, Taipei, Taiwan,* [d] *Department of Family Medicine, Taipei Veterans General Hospital, YuanShan Branch, YiLan County, Taiwan,* [e] *Department of Geriatrics, Zhejiang Hospital, Hangzhou, Zhejiang Province, People's Republic of China,* [f] *Center for Geriatrics and Gerontology, Kaohsiung Veterans General Hospital, Kaohsiung, Taiwan,* [g] *Center for Geriatrics and Gerontology, Taipei Veterans General Hospital, Taipei, Taiwan*

ARTICLE INFO

Accepted 7 December 2018

Keywords:
balance,
dynapenia,
function decline,
mortality

SUMMARY

Background: Dynapenia and poor balance is at central part of frailty and is associated with function declining in community-dwelling older people. Little was known the consequences of dynapenia and poor balance among older inpatients. This study aimed to evaluate the impact of dynapenia and balance on functional and mortality outcomes.
Methods: All patients received baseline comprehensive geriatric assessment (CGA) and would be follow up from six to nine month after discharge. CGA included basic demography, multimorbidity, cognitive function, nutritional status, risk of fall, depressive symptoms, mobility, and balance subscale of Tinetti performance oriented mobility assessment. A composite outcome composed of mortality and function decline.
Results: Of 150 patients, 108 (72%) were dynapenia and 72 (48%) were poor balance. 39 (26%) experienced a composite outcome during follow-up period. Univariate Cox PH model showed that age (hazard ratio (HR): 1.1; 95% confidence interval (CI): 1.0–1.2, $p = 0.039$), dynapenia (HR: 8.1; 95% CI: 1.1–59.2, $p = 0.040$), and poor balance (HR: 2.9; 95% CI: 1.3–6.3, $p = 0.009$) were associated with the composite outcome. Results of age adjusted Cox PH analysis for the composite outcome and function declining were similar. In the multivariate Cox PH model adjusted for corresponding variables, those dynapenic and poor balance older inpatients had higher risk than non-dynapenic and intact balance ones to experience the composite outcome (HR: 8.0; 95% CI :0.9–71.0, $p = 0.062$) and function decline (HR: 6.8; 95% CI: 0.8–61.7, $p = 0.086$), respectively.
Conclusion: Dynapenia and balance were associated with a composite outcome of function decline and mortality. Incorporate routine screening of dynapenia and balance in admission assessments would identify people at risk and may benefit their six-month post-discharge outcome.

1. Introduction

Population aging is a global challenge, and extensively impacts financial security, labor markets and health care systems,[1] which resulting from increasing medical expenditure and care burden among older adults.[2] Achieving healthy and active aging would be a solution to reduce medical expenditure and save senior labor.[3] Both multimorbidty management and disability prevention have great impact on health.[4,5]

Identifying high-risk older hospitalized patients and applying different therapeutic strategies are important in clinical practice. To precisely predict clinical outcomes for older patients, physical and functional status have been involved in several assessment instruments.[6–9] A study of 12,804 acutely-disable patients following for 11 years showed that multimorbidity and disability interacted synergistically to increase mortality risk,[10] which demonstrated the importance of multimorbidity management and function reserve in clinical practice.

Frailty, *per se*, is a powerful predictor for rehospitalizatoin, in-hospital mortality and long-term mortality.[11] Early identification of frailty among older hospitalized patients would be the first step to implement frailty into clinical practice.[12] It is not surprising that a recent systemic review demonstrated 262 modified frailty phenotypes in the literature when a golden standard of operative definition for frailty have not emerged yet.[13] Muscle strength and slow walking speed are performance-based phenotypes of frailty defined by Cardiovascular Health study. Dynapenia refers to either slowness or weakness,[14] and is associated with physical activity, sarcopenia and cognitive impairment.[15,16] Intervention studies have

* Corresponding author. Center for Geriatrics and Gerontology, Taipei Veterans General Hospital, No. 201, Sec 2, Shih-Pai Road, Taipei, Taiwan.
E-mail addresses: lkchen2@vghtpe.gov.tw (L.-K. Chen)
Co-corresponding author. Department of Geriatrics, Zhejiang Hospital, No. 12, Lingyin Road, Hangzhou, Zhejiang Province, People's Republic of China.
E-mail addresses: lily197459@163.com (X. J. Chen)
#, * Indicated equal contribution.

shown that comprehensive care plans eventually improve clinical outcomes.[17] In recent studies of Canadian and Chinese community-dwelling old people showed balance and trunk posture adaptation were with prevalent and incident frailty.[18,19] A 10-year follow-up study of 1085 older community-dwelling Japanese showed independent association between standing balance and mortality beyond slow walking speed and weak grip strength.[20]

Although the association between dynapenia, balance and clinical outcomes had been clearly shown among older community-dwelling adults, little was known regarding to their prognostic value for long-term outcomes among older hospitalized patients. The aim of this study was to evaluate the association between dynapenia, balance and on six-month post-discharge outcome among older patients who survived the acute illnesses.

2. Material and methods

2.1 Study design and participants

This is a prospective cohort study conducted in the Zhejiang Hospital, where is a tertiary hospital and responsible for geriatric care. All patients admitted to the geriatric evaluation unit between Oct, 2014 and Oct, 2015 consecutively were enrolled after fully consented. All patients were clinically followed by telephone survey or home visits at six to nine months after discharge. The performance and reporting format adherent to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies.[21] The whole study has been approved by the institutional review board of Zhejiang Hospital. All participants provided fully informed written consent and the methods were carried out in accordance with the ethical principles of the Helsinki Declaration.

2.2 Comprehensive geriatric assessment

For all patients, 7 comprehensive geriatric assessment (CGA) was performed by the same nurse during the study period. Demographic data of all participants were collected, including age, sex, current smoking in the past month (yes versus no), and current drinking in the past month (yes versus no). CGA composed of functional assessments of multiple dimensions, such as physical, cognition, nutrition, mood, and other function assessments. Prehospital disability was defined as any deficits of Barthel Index (BI),[22] Chinese version of mini-mental state examination (MMSE) < 24 was defined as cognitive impairment.[23] Chinese version of Geriatric Depression Scale-15 (GDS-15) ≤ 5 was defined as depressive mood.[24] Morse fall risk assessment > 45 was defined as high risk of fall.[25] The multimorbidity status of individual participant was evaluated by using the cumulative illness rating scale for geriatrics (CIRS-G),[26] which included assessment for both diseases and severity. The risk of malnutrition was defined by the mini-nutritional assessment-short form (MNA-SF) ≤ 11.[27] Tinetti performance-oriented mobility assessment (POMA) < 19 and its balance subscale (POMA-B) ≤ 12.5 were used to defined poor mobility and balance, respectively.[28,29]

2.3 Dynapenia

Dynapenia was defined as either lower muscle strength or slow walking speed. Dominant-hand muscle strength was measured by dynamometers for three times with an allowed pre-trial at a seated position.[30] Maximum values of them were selected for analysis. Weakness was defined as < 26 kg for men and < 18 kg for women.[31] Walking speed was measured as a static-start and non-decelerating stop in 4-meter distance. Those with walking speed < 0.8 meter/second were defined as slowness.[32]

2.4 Clinical outcomes

All patients were followed by telephone survey or home visits at six to nine months after discharge to evaluate their survival status and incidental function decline. Function decline was defined as decreasing Barthel Index at the end of follow-up. A composite outcome composed of function decline, and mortality. The follow-up period for the study started from admission and dates of post-discharge follow-up.

2.5 Statistical analysis

In this study, continuous variables were expressed as mean $\pm$ standard deviation when visual normal probability plots met normality assumptions, whereas categorical data were expressed as number (percentage). Comparisons between continuous variables were performed by Student's t test or Mann-Whiney U test when appropriate and the comparisons between categorical data were done by Chi square test or Fisher-Exact test. Cox proportional hazard model was used for survival analysis. The proportional-hazards assumption for both models was tested within the PROC PHREG module. A p-value from two-sided tests < 0.05, and 95% CIs not spanning the null hypothesis values were considered statistically significant. All analyses were performed using the SAS statistical package, version 9.4 for windows (SAS Institute, Inc., Cary, NC, USA).

3. Results

During the mean follow-up period of 210 days, 150 patients (81.5 ± 7.0 years, 64% male) were enrolled. Among them, 68 (45.3%) participants posed both dynapenia and poor balance. Table 1 summarized comparisons between dynapenic and non-dynapenic patients, which showed that dynapenic patients were older, and had higher proportion of prehospital disability, higher proportion of cognitive impairment, higher proportion of fall risk, and higher proportion of poor balance (Table 1). Table 1 summarized the differences in basic demography and function assessments by balance status. 72 (48%) patients had poor balance. Compared to normal balance (POMA-B > 12.5), poor balance patients were older, higher morbidity and had higher proportion of prehospital disability, higher proportion of cognitive impairment, higher proportion of malnutrition risk, higher proportion of fall risk, and higher proportion of dynapenia (Table 1).

Univariate Cox PH model was used to examine the association between function assessments and functional declining, mortality and a composite outcome (Table 2). Age, poor balance, dynapenia, weakness, and slowness were all associated with a composite outcome of function decline and mortality. Subgroup analysis was done for function decline and mortality, respectively. The results were similar in function decline but insignificant in mortality, which might be limited to small sample sizes.

Age-adjusted and multivariate Cox PH model adjusted for age, sex, morbidity (CIRS-G), cognition (MMSE), nutrition (MNA-SF), risk of fall (Morse fall risk score), and prehospital disability were used to explore the association between dynapenia, balance, their combination and outcome of interests (Table 3).

Table 1
Comparisons of demographic characteristics among older hospitalized inpatients with and without dynapenia.

	Total	Dynapenia	Non-dynapenia	*p* value	POMA-B ≤ 12.5	POMA-B > 12.5	*p* value
n (%)	150	108 (72.0)	42 (28.0)		72 (48.0)	78 (52.0)	
Age, mean (SD)	81.5 ± 7.0	83.0 ± 6.2	77.7 ± 7.6	**< 0.001**	84.3 ± 5.4	78.9 ± 7.3	**< 0.001**
Men, n (%)	64.0	57.9	65.9	**< 0.001**	28 (38.9)	26 (33.3)	0.479
Current smoking, n (%)	12 (8.0)	6 (5.6)	6 (14.3)	0.096	5 (6.9)	7 (9.0)	0.647
Current drinking, n (%)	15 (10.0)	7 (6.5)	8 (19.1)	0.032	5 (6.9)	10 (12.8)	0.231
Pre-hospital disability, n (%)	53 (35.3)	53 (49.1)	0 (0.0)	**< 0.001**	47 (65.3)	6 (7.7)	**< 0.001**
Body mass index	23.7 (3.7)	23.9 (3.8)	23.1 (3.3)	0.253	23.6 ± 4.0	23.6 ± 3.4	0.911
Multimorbidity							
CIRS-G mean (SD)	10.2 ± 4.1	10.2 ± 4.3	10.4 ± 3.7	0.774	11.2 ± 4.2	9.3 ± 3.8	**0.005**
Stroken (%)	34 (22.7)	25 (23.2)	9 (21.4)	0.821	22 (30.6)	12 (15.4)	**0.026**
Chronic heart diseasen (%)	71 (47.3)	48 (44.4)	23 (54.8)	0.256	32 (44.4)	39 (50.0)	0.496
COPD, n (%)	22 (14.7)	16 (14.8)	6 (14.3)	0.935	9 (12.5)	13 (16.7)	0.471
Functional assessment							
MMSE, n (%)	48 (32.0)	40 (37.0)	8 (19.1)	**0.034**	32 (44.4)	16 (20.5)	**0.002**
GDS-15 > 5, n (%)	30 (20.0)	25 (23.2)	5 (11.9)	0.122	17 (23.6)	13 (16.7)	0.288
MNA-SF ≤ 11, n (%)	62 (41.3)	47 (43.5)	15 (35.7)	0.384	37 (51.4)	25 (32.1)	**0.016**
Morse fall risk score > 45, n (%)	49 (32.7)	45 (41.7)	4 (9.5)	**< 0.001**	39 (54.2)	10 (12.8)	**< 0.001**
POMA-B	72 (48.0)	68 (63.0)	4 (9.5)	**< 0.001**			
Dynapenia	108 (72.0)				68 (94.4)	40 (51.3)	**< 0.001**
Weakness, n (%)	54 (36.0)	54 (50.0)	0 (0.0)	**< 0.001**	65 (90.3)	24 (30.8)	**< 0.001**
Slowness, n (%)	89 (59.3)	89 (82.4)	0 (0.0)	**< 0.001**	89 (82.4)	0 (0.0)	**< 0.001**

SD, standard deviation; CIRS-G, cumulative illness rating scale for geriatrics; COPD, chronic obstructive pulmonary disorder; MMSE, mini-mental state examination; GDS-15, geriatric depression Scale-15; MNA-SF, mini-nutritional assessment-short form; POMA-B, balance subscale of Tinetti performance oriented mobility assessment. Bold type indicates statistical significance.

Table 2
Univariate Cox proportional hazard model to explore the association between components of comprehensive geriatric assessments and function decline, mortality and composite outcome.

	Composite (n = 39)		Function decline (n = 31)		Mortality (n = 8)	
	HR (95% CI)	p	HR (95% CI)	p	HR (95% CI)	p
Age	1.1 (1.0–1.2)	**0.039**	1.1 (1.0–1.2)	**0.047**	1.0 (0.9–1.2)	0.533
Men	1.3 (0.6–2.6)	0.490	1.5 (0.7–3.3)	0.317	0.9 (0.2–4.5)	0.901
POMA < 19	1.8 (0.9–3.5)	0.074	1.9 (0.9–4.0)	0.099	1.4 (0.4–5.8)	0.607
POMA-B ≤ 12.5	2.9 (1.3–6.3)	**0.009**	3.7 (1.4–9.7)	**0.009**	1.3 (0.3–5.7)	0.684
Dynapenia	8.1 (1.1–59.2)	**0.040**	6.2 (0.8–46.0)	0.075	12613436.0 (0.0-.)	0.995
Walk speed						
Continuous (per m/s)	0.3 (0.1–1.2)	0.087	0.3 (0.1–1.2)	0.080	0.7 (0.0–11.7)	0.788
Slowness (< 0.8 m/s)	3.9 (1.2–12.9)	**0.026**	2.9 (0.9–9.9)	0.085	14941497.0 (0.0-.)	0.994
Handgrip strength						
Continuous (per kg)	0.9 (0.9–1.0)	**0.003**	0.9 (0.9–1.0)	**0.018**	0.9 (0.8–1.0)	**0.036**
Weakness	2.1 (1.1–4.0)	**0.030**	2.0 (1.0–4.3)	0.064	2.8 (0.7–11.3)	0.145
MMSE < 24	1.3 (0.7–2.6)	0.387	1.2 (0.6–2.6)	0.620	1.9 (0.5–7.6)	0.369
GDS > 5	1.2 (0.6–2.5)	0.652	1.3 (0.6–3.1)	0.533	1.1 (0.2–5.4)	0.915
MNA-SF ≤ 11	1.6 (0.8–3.1)	0.160	1.2 (0.6–2.6)	0.615	3.6 (0.9–15.3)	0.078
Morse > 45	1.6 (0.8–3.0)	0.183	1.9 (0.9–3.9)	0.100	1.0 (0.2–4.2)	0.987
CIRS-G	1.0 (0.9–1.1)	0.851	1.0 (0.9–1.1)	0.781	1.0 (0.8–1.2)	0.905
Prehospital disability	1.9 (1.0–3.9)	0.057	1.7 (0.8–3.6)	0.199	3.2 (0.6–16.0)	0.158

HR, hazard ratio; CI, confidence interval; POMA, Tinetti performance oriented mobility assessment; POMA-B, balance subscale of Tinetti performance oriented mobility assessment; CIRS-G, cumulative illness rating scale for geriatrics; MMSE, mini-mental state examination; GDS-15, geriatric depression Scale-15; MNA-SF, mini-nutritional assessment-short form. Bold type indicates statistical significance.

Table 3
Multivariate Cox PH model to explore the association between dynapenia, poor balance and composite outcome of function decline, and mortality.

	Composite outcome				Function declining			
	Age adjusted model		Full adjusted model		Age adjusted model		Full adjusted model	
	HR (95% CI)	*p*	HR (95% CI)	*p*	HR (95% CI)	*p*	HR (95% CI)	*p*
Dynapenia	6.2 (0.8–46.8)	0.079	5.5 (0.7–44.5)	0.107	4.5 (0.6–34.5)	0.153	4.0 (0.5–32.5)	0.201
Slowness	2.9 (0.8–10.8)	0.115	2.7 (0.7–10.8)	0.168	1.9 (0.5–7.3)	0.359	1.8 (0.4–7.4)	0.439
Weakness	2.2 (1.1–4.2)	0.019	8.2 (2.3–29.7)	0.001	2.1 (1.0–4.5)	0.049	4.5 (0.9–21.5)	0.063
Poor balance	2.3 (1.0–5.5)	0.054	2.4 (0.8–7.0)	0.105	2.9 (1.0–8.4)	0.043	3.6 (1.1–12.2)	0.037
No dynapenia and good balance	Reference		Reference		Reference		Reference	
Either dynapenia or poor balance	4.2 (0.5–34.7)	0.183	4.1 (0.5–35.3)	0.195	2.4 (0.3–21.9)	0.441	2.1 (0.2–20.3)	0.505
Dynapenia and poor balance	7.5 (1.0–59.4)	0.055	8.0 (0.9–71.0)	0.062	5.9 (0.7–47.6)	0.098	6.8 (0.8–61.7)	0.086

Full model adjusted for age, sex, CIRS-G, MMSE, MNA-SF, Morse fall risk score, and prehospital disability.

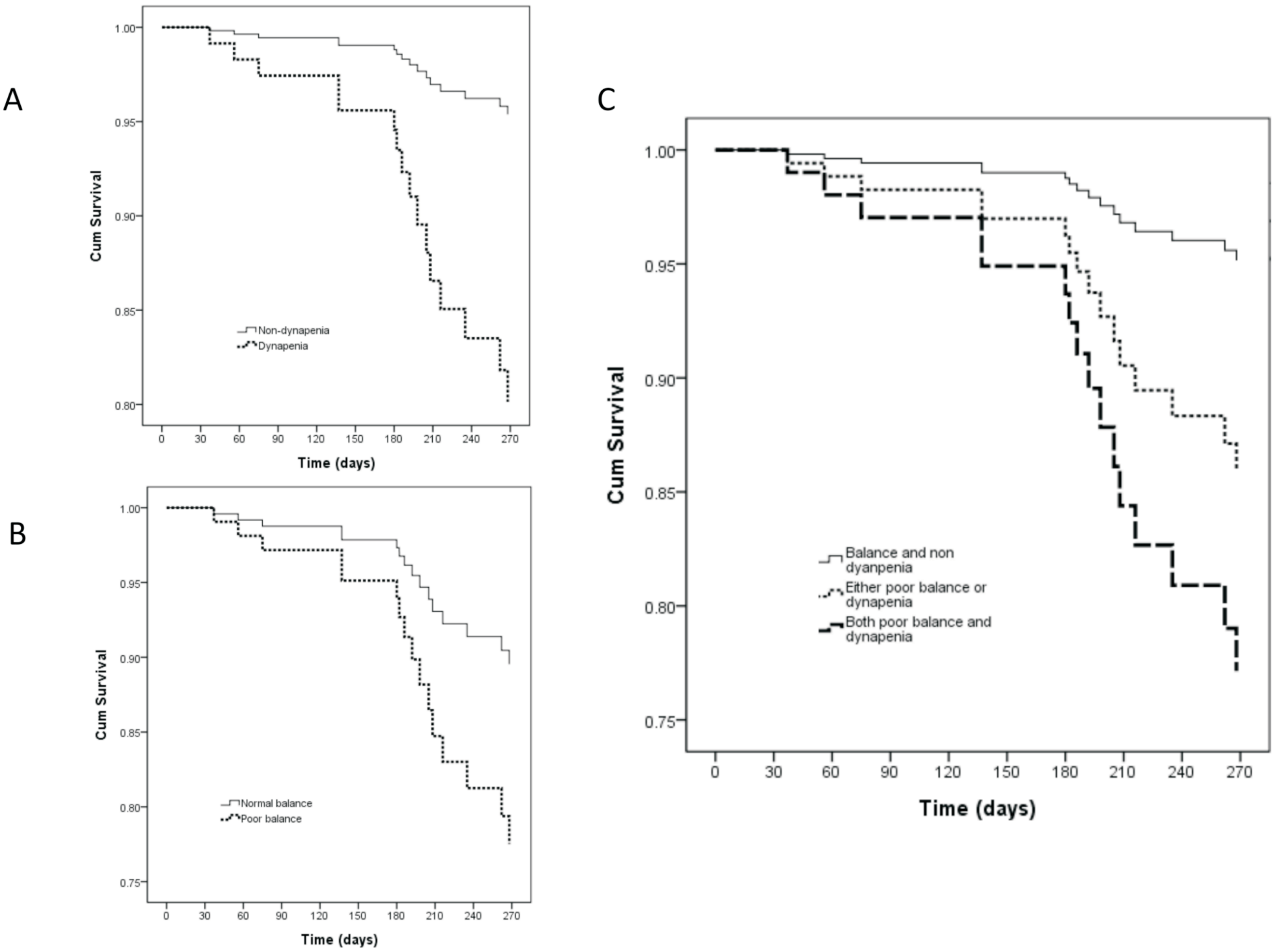

Fig. 1. A Kaplan-Meier curve estimates the associations of the composite outcome and (A) dynapenia, (B) poor balance and (C) combined effects.

4. Discussion

In this study, we found that dynapenia, and poor balance were significant associated with a composite outcome of function decline and mortality. The sensitivity analysis demonstrated the similar associations. Compared to non-dynapenic and intact static and dynamic balance patients, those dynapenic and poor balance patients had higher risk to experience a composite outcome (hazard ratio: 7.5, 95% confidence interval 1.0–59.4). To the best of our knowledge, this is the first study that evaluated the prognostic role of dynapenia and static and dynamic balance among older hospitalized patients in China.

Piles of studies demonstrated the association between frailty and functional decline, re-hospitalization and mortality in community-dwelling older people[32] and in-patients.[11,33,34] Unfortunately, a lot of modified frailty definition made clinical implication and comparison much difficult. Theou et al. compared 262 modified frailty phenotypes and suggested that performance-based phenotype would impact the results most.[13] Researchers found that muscle strength and walking speed are associated with mortality.[9,35] Manini et al. proposed a working algorithm for dynapenia to combine muscle strength and performance for clinical practice and disability prevention.[36] In recent years, some epidemiological studies showed the dynapenia is associated with cognition, function decline and sarcopenia.[16] Results from the study extended dynapenia research from community-dwelling old people to in-hospitalization ones. Our recent study showed that handgrip strength improved prediction of cardiovascular and all-cause mortality better than walking speed among middle and older Taiwanese.[8] Results from the study showed weakness was the most powerful single predictor for function decline (HR: 8.2, 95% CI: 2.3–29.7, p = 0.001) or a composite outcome (HR: 4.5, 95% CI: 0.9–21.5, p = 0.063). Moreover, differences exist between Asian and the Caucasian people in muscle health,[37] which value the study further.

A study of 1085 aged 65 to 89 years nondisabled Japanese followed up for 10 years suggested that static balance, independent of walking speed and handgrip strength, is associated with mortality.[20] Merchant et al. suggested trunk posture in walking would be a better screening tool for subsequent frailty than walking speed.[18] Findings from the study showed that poor balance patients had higher risk of subsequent function declining. Combining dynapenia and balance, the dynapenic and poor balance patients had higher risk experiencing function decline and a composite outcome of function decline and mortality.

Geriatric medicine is budding and raising more and more attention when the era of population ageing arrives in China. Comprehensive geriatric assessment-based assessment and interdisciplinary intervention have showed its effectiveness on functional outcomes.[38] Findings from the study suggested dynapenia and balance were associated with function decline and mortality. Routine screening handgrip strength, walking speed and balance status would identify patients at risk earlier. Then, implement multi-domain interventions, including physical and psychological function,[32,39] in those frail patients to prevent disability, to maintain function, to improve quality of life,[40] and to reduce mortality.

Despite all efforts ran into this study, there are some limitations. First, limited to the observational study design, findings from the study only showed the prognostic value of dynapenia and balance. Further interventional studies are needed to evaluate the reversibility of dynapenia and the associated clinical benefits. Second, fewer events limited the possibility of further sex-specific analysis. Third, walking speed was measured by 4-meter distance, which may slow the gait speed.

5. Conclusion

Dynapenia and balance played an important role in the long-term function outcomes and mortality of older hospital inpatients in China. Both physical indicators should be incorporated in a routine comprehensive screening and care plan. Further interventional study is needed to evaluate the reversibility of dynapenia and balance status among inpatients and the associated benefits after intervention.

Acknowledge

This study was supported by Zhejiang Medical Science and Technology Project (2016139072). All authors declare no conflict of interest.

Disclosures

The authors have declared no conflict interests exist.

References

1. Chen LK. Towards the life course approach of healthy aging. *Eur Geriatr Med.* 2016;7:289–290.
2. Tung HH, Chu KH, Lien RY, et al. The needs of caring people with dementia and their family care-givers. *J Clin Gerontol Geriatr.* 2018;9:3–4.
3. Jaspers L, Schoufour JD, Erler NS, et al. Development of a healthy aging score in the population-based rotterdam study: Evaluating age and sex differences. *J Am Med Dir Assoc.* 2017;18:276.e1–276.e7.
4. Barnett K, Mercer SW, Norbury M, et al. Epidemiology of multimorbidity and implications for health care, research, and medical education: A cross-sectional study. *Lancet.* 2012;380:37–43.
5. Landi F, Calvani R, Tosato M, et al. Impact of physical function impairment and multimorbidity on mortality among community-living older persons with sarcopaenia: Results from the ilSIRENTE prospective cohort study. *BMJ Open.* 2016;6:e008281.
6. Hickman LD, Phillips JL, Newton PJ, et al. Multidisciplinary team interventions to optimise health outcomes for older people in acute care settings: A systematic review. *Arch Gerontol Geriatr.* 2015;61:322–329.
7. Chodos AH, Kushel MB, Greysen SR, et al. Hospitalization-associated disability in adults admitted to a safety-net hospital. *J Gen Intern Med.* 2015;30:1765–1772.
8. Lee WJ, Peng LN, Chiou ST, et al. Physical health indicators improve prediction of cardiovascular and all-cause mortality among middle-aged and older people: A National Population-based Study. *Sci Rep.* 2017;7:40427.
9. Leong DP, Teo KK, Rangarajan S, et al. Prognostic value of grip strength: Findings from the Prospective Urban Rural Epidemiology (PURE) study. *Lancet.* 2015;386:266–273.
10. Chen C, Sia I, Ma HM, et al. The synergistic effect of functional status and comorbidity burden on mortality: A 16-year survival analysis. *PLoS One.* 2014;9:e106248.
11. Kahlon S, Pederson J, Majumdar SR, et al. Association between frailty and 30-day outcomes after discharge from hospital. *CMAJ.* 2015;187:799–804.
12. Vellas B, Cestac P, Moley JE. Implementing frailty into clinical practice: We cannot wait. *J Nutr Health Aging.* 2012;16:599–600.
13. Theou O, Cann L, Blodgett J, et al. Modifications to the frailty phenotype criteria: Systematic review of the current literature and investigation of 262 frailty phenotypes in the Survey of Health, Ageing, and Retirement in Europe. *Ageing Res Rev.* 2015;21:78–94.
14. Clark BC, Manini TM. What is dynapenia? *Nutrition.* 2012;28:495–503.
15. Iwamura M, Kanauchi M. A cross-sectional study of the association between dynapenia and higher-level functional capacity in daily living in community-dwelling older adults in Japan. *BMC Geriatr.* 2017;17:1.
16. Huang CY, Hwang AC, Liu LK, et al. Association of dynapenia, sarcopenia, and cognitive impairment among community-dwelling older Taiwanese. *Rejuvenation Res.* 2016;19:71–78.
17. Lee PH, Lee YS, Chan DC. Interventions targeting geriatric frailty: A systemic review. *J Clin Gerontol Geriatr.* 2012;3:47–52.
18. Merchant RA, Banerji S, Singh G, et al. Is trunk posture in walking a better marker than gait speed in predicting decline in function and subsequent frailty? *J Am Med Dir Assoc.* 2016;17:65–70.
19. Davis DH, Rockwood MR, Mitnitski AB, et al. Impairments in mobility and balance in relation to frailty. *Arch Gerontol Geriatr.* 2011;53:79–83.
20. Nofuji Y, Shinkai S, Taniguchi Y, et al. Associations of walking speed, grip strength, and standing balance with total and cause-specific mortality in a general population of Japanese elders. *J Am Med Dir Assoc.* 2016; 17:184 e181–e187.
21. von Elm E, Altman DG, Egger M, et al. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: Guidelines for reporting observational studies. *Lancet.* 2007;370:1453–1457.
22. Mahoney FI, Barthel DW. Functional evaluation: The Barthel Index. *Md State Med J.* 1965;14:61–65.
23. Folstein MF, Folstein SE, McHugh PR. “Mini-mental state”. A practical method for grading the cognitive state of patients for the clinician. *J Psychiatr Res.* 1975;12:189–198.
24. Chan AC. Clinical validation of the Geriatric Depression Scale (GDS): Chinese version. *J Aging Health.* 1996;8:238–253.
25. Morse JM, Morse RM, Tylko SJ. Development of a scale to identify the fall-prone patient. *Can J Aging.*1989;8:366–377.
26. Parmelee PA, Thuras PD, Katz IR, et al. Validation of the Cumulative Illness Rating Scale in a geriatric residential population. *J Am Geriatr Soc.* 1995;43:130–137.
27. Guigoz Y, Lauque S, Vellas BJ. Identifying the elderly at risk for malnutrition. The Mini Nutritional Assessment. *Clin Geriatr Med.* 2002; 18:737–757.
28. Tinetti ME. Performance-oriented assessment of mobility problems in elderly patients. *J Am Geriatr Soc.* 1986;34:119–126.
29. An S, Lee Y, Lee G. Validity of the performance-oriented mobility assessment in predicting fall of stroke survivors: A retrospective cohort study. *Tohoku J Exp Med.* 2014;233:79–87.
30. Roberts HC, Denison HJ, Martin HJ, et al. A review of the measurement of grip strength in clinical and epidemiological studies: Towards a standardised approach. *Age Ageing.* 2011;40:423–429.
31. Chen LK, Liu LK, Woo J, et al. Sarcopenia in Asia: Consensus report of the asian working group for sarcopenia. *J Am Med Dir Assoc.* 2014;15(2): 95–101.
32. Lin SY, Lee WJ, Chou MY, et al. Frailty index predicts all-cause mortality for middle-aged and older Taiwanese: Implications for active-aging programs. *PLoS One.* 2016;11:e0161456.
33. Basic D, Shanley C. Frailty in an older inpatient population: Using the clinical frailty scale to predict patient outcomes. *J Aging Health.* 2015; 27(4):670–685.
34. Wallis SJ, Wall J, Biram RW, et al. Association of the clinical frailty scale with hospital outcomes. *QJM.* 2015;108:943–949.
35. Studenski S, Perera S, Patel K, et al. Gait speed and survival in older adults. *JAMA.* 2011;305:50–58.
36. Manini TM, Clark BC. Dynapenia and aging: An update. *J Gerontol A Biol Sci Med Sci.* 2012;67:28–40.
37. Chen LK, Lee WJ, Peng LN, et al. Recent advances in sarcopenia research in Asia: 2016 update from the Asian Working Group for Sarcopenia. *J Am Med Dir Assoc.* 2016;17:767 e761–e767.
38. Lee WJ, Peng LN, Cheng YY, et al. Effectiveness of short-term interdisciplinary intervention on postacute patients in Taiwan. *J Am Med Dir Assoc.* 2011;12:29–32.
39. Badrasawia M, Shahara S, Singh D. Risk factors of frailty among multiethnic Malaysian older adults. *Int J Gerontol*. 2017;11:154–160.
40. Lin YC, Chang JC, Chen YM, et al. Health related quality of life among frail and pre-frail older adults in Taiwan. *Int J Gerontol*. 2017;11:249–252.