International Journal of Gerontology 19 (2025) 81–86
https://doi.org/10.6890/IJGE.202504_19(2).0004

International Journal of Gerontology

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

Original Article

Sarcopenia among Older Adults Admitted to Hospital

Safiyyah Nurnajah Wan [a], Julia Engkasan [b], Terence Ong [a *]

[a] *Department of Medicine, Faculty of Medicine, Universiti Malaya, Kuala Lumpur, Malaysia,* [b] *Department of Rehabilitation Medicine, Faculty of Medicine, Universiti Malaya, Kuala Lumpur, Malaysia*

ARTICLE INFO

Accepted 19 December 2024

Keywords:
sarcopenia,
aged,
prevalence,
hand strength

SUMMARY

Background: This study investigated the prevalence of sarcopenia among older adults during hospitalization in an acute care setting, its associated risk factors, and health outcomes. The study also examined sarcopenia assessment uptakes among older adults admitted to the hospital.
Methods: Patients admitted to geriatric and medical wards in a university hospital were included. Sarcopenia was determined through calf circumference measurement, hand grip strength, and a 5-time chair stand test using Asian Working Group for Sarcopenia (AWGS) thresholds. Participants were followed up 28 days post-discharge.
Results: Seventy-nine participants were included in this study, all completing calf circumference and hand grip strength assessments. Seventeen participants completed the Bioelectrical Impedance Analysis (BIA) assessment (21.5%), twelve participants completed Dual-energy X-ray Absorptiometry (DXA) (9.5%), and twenty-four completed 5-time chair stand tests (19%). Forty-nine out of 79 (62%) participants had sarcopenia, 63% of the participants had low calf circumference (median 31.4 cm, IQR: 2.8), 93.7% had low grip strength (median 11 kg, IQR: 9), and 94.9% had prolonged 5-time chair stand test. The body mass index (BMI) was significantly lower in sarcopenic participants in this study. No significant associations were found between sarcopenia diagnosis and health outcomes.
Conclusion: This study highlighted a high prevalence of sarcopenia among older individuals in hospitals. Low uptakes of muscle mass and physical performance assessments suggest diagnostic challenges in acute care settings.

1. Introduction

Hospitalization has been shown to result in a rapid decrease in muscle mass and function due to a combination of acute inflammation and sudden muscle disuse from physical inactivity, possibly causing individuals to develop sarcopenia.[1] Older patients with sarcopenia have double the risk of hospital readmission,[2] are over three times more likely to die there, and have higher mortality rate after discharge.[3] In Asia, sarcopenia prevalence in hospital settings varied based on definitions used (31% in China,[4] 76.8% in Japan,[5] 46.5% in Korea[6] and 34.3% in Vietnam.[7] However, these studies examined patients admitted to various clinical subspecialty wards, thus may not depict the actual prevalence of sarcopenia among acutely ill older patients in hospitals.

As diagnostic definitions of sarcopenia evolve, their utilization differed among studies, limiting direct comparisons,[8] especially in the acute care setting. The lack of consensus on the definition of sarcopenia in hospital settings has limited the development of function-promoting therapies and hindered the identification of associated adverse health outcomes.[9,10] Hence, this study aimed to examine sarcopenia assessment uptakes among older adults admitted to hospital, the prevalence of sarcopenia, its associated risk factors, and health outcomes. This study explores sarcopenia assessment methods' uptake, highlighting practical challenges in diagnosing sarcopenia in acute care settings, thereby recommending improved protocols for clinical practice.

2. Methods

This prospective observational study involved patients over 65 years old admitted to the geriatric medicine ward or a medical admission unit of a teaching university hospital. Based on a conservative sarcopenia prevalence of 27% in hospitals,[11] with a precision of 85% and an expected 20% attrition rate, the initial sample size needed was 180 participants. However, due to the nationwide COVID-19 lockdown, a convenience sampling approach was used. Screening for participants began from April 2021 to June 2021, and then resumed in September 2021 to July 2022 due to the lockdown (total duration: 14 months). Eligible participants underwent sarcopenia assessment within the first three days of admission. Follow-up was done after 28 days via telephone to look for health outcomes.

2.1. Muscle mass, strength, and physical performance assessment

Calf circumference measurement was done using a non-elastic tape on the participant's dominant leg while sitting with knees

* Corresponding author. Department of Medicine, Faculty of Medicine, Universiti Malaya, 50603 Kuala Lumpur, Malaysia.
E-mail address: terence.ong@ummc.edu.my (T. Ong)

flexed at 90° on the thickest part of the calf. Bioelectrical Impedance Analysis (BIA) measurement for Appendicular Skeletal Muscle Index (ASMI) was calculated using the Rangel-Peniche et al.[12] formula using TANITA Total Body Composition Analyser TBF-300/TBF-300A. The participants were assessed standing up unsupported, with feet slightly apart on the BIA device for about 1 minute for the impedance to be analyzed. Dual X-ray Absorptiometry (DXA) measurement for ASMI was done using GE Lunar iDXA with the participant lying supine.

Muscle strength was assessed using a Jamar hand grip dynamometer (Model J00105, Lafayette Instrument Company, USA) using the participant's dominant hand. Due to limited available space in the included wards, physical performance was assessed through the 5-time chair stand test.

2.2. Sarcopenia screening and diagnosis

Sarcopenia risk was assessed using SARC-F and SARC-CalF. Sarcopenia was defined by low ASMI either by BIA (sarcopenia (BIA) if ASMI < 7.0 kg/m^2 in men and < 5.7 kg/m^2 in women) or DXA (sarcopenia (DXA) if ASMI < 7.0 kg/m^2 in men and < 5.4 kg/m^2 in women) alongside either low hand grip strength (< 28 kg for men and < 18 kg for women) or poor physical performance (≥ 12 s for 5-time chair stand test). 'Sarcopenia (CC)' was defined as low calf circumference (< 34 cm in men, < 33 cm in women) and; either low hand grip strength; and/or physical performance. This corresponds to the AWGS recommendation for muscle mass assessment when BIA or DXA are not available.[13] 'Severe sarcopenia' was determined when a participant was found to have collective impairment of muscle mass, strength, and physical performance.

2.3. Data handling and analysis

Patient data were extracted from participants' clinical notes on their Electronic Medical Records (EMR). Descriptive findings were described using frequency tables for categorical data and mean with standard deviations or medians with interquartile ranges, depending on normality testing. Completion rate was described by the percentage of participants able to complete each of the assessments. Comparison was made between sarcopenia prevalences based on different muscle mass measurements. The association between participants' characteristics was assessed and analyzed using logistic regression. Differences between sarcopenia (low calf circumference with either low hand grip strength and/or poor 5-time chair stand test) and no sarcopenia groups in terms of risk factors and health outcomes (inpatient complications, hospital readmission, and mortality) were reported. In cases of missing data, complete case analysis or pairwise deletion was done, focusing only on those with complete information. Statistical analysis was done using SPSS (Version 26.0, IBM Corp., Armonk, New York, USA). The study was approved by UMMC-MREC Review Board (MREC 2021914-10588).

3. Results

A total of 846 patients were screened. The participant recruitment flowchart is illustrated in Figure 1.

The demographics of the included participants are described in Table 1. Assessment was made at median 3 days (IQR: 6), with median length of hospital stay of 9 days (IQR: 12). Forty-six (58.2%) participants were admitted due to an infection. The median early warning score of all participants on admission was 1 (IQR: 1).

3.1. Sarcopenia assessment uptake

The BIA assessment was completed by 17 (21.5%) participants. Reasons for failure to complete were body weakness (n = 42), pain (n = 14), a history of below-knee amputation (n = 2), and fear of falling (n = 4). As for DXA, only 12 (9.5%) participants completed DXA assessments due to limited slots for inpatient DXA, pandemic restrictions, long waiting times, participants' ability to transfer, and the unavailability of an imaging technician. Note that all participants completed calf circumference measurements. Only one participant managed to complete all muscle mass assessments.

Only 24 (19%) participants completed 5-time chair stand tests. Those who were unable to do so were because of pain (n = 5), weakness (n = 46), and instability (n = 4). Other assessment uptake findings are summarized in Table 2.

3.2. Sarcopenia screening and prevalence

37/79 (46.8%) of participants were at risk for sarcopenia based on SARC-F. By contrast, more participants (n = 40, 50.6%) were at risk for sarcopenia based on SARC-CalF. Bot tools had small to medium effect sizes; with Cohen's h for the difference in prevalence between AWGS and SARC-F was 0.25, and Cohen's h = 0.23 for difference between the AWGS criteria and SARC-CalF.

Out of 17 participants who were able to complete the BIA assessment, based on the Peniche et al. formula, 7 (41.2%) participants had a low ASMI (median: 6 kg/m^2 IQR: 2.3). Out of 12 participants who completed the DXA assessment, 8 (66.7%) of them had a low ASMI on DXA (median: 6.4 kg/m^2 IQR: 1.4). Fifty (n = 50) participants from 79 total participants (63.3%) were found to have low calf circumference based on AWGS cut-off points. The median calf circumference was 31.4 cm (IQR: 4.5) on admission. Only one participant completed all assessment modalities.

The 74/79 (93.7%) had low hand grip strength based on AWGS cut-off points. Median hand grip strength was 11 kg (IQR: 9). And 75/79 (94.9%) participants had prolonged sit-to-stand tests. The median duration was 19 s (IQR: 13.5).

Forty-nine out of 79 participants were found to have sarcopenia when calf circumference was used as a muscle mass surrogate. The overall prevalence of sarcopenia (CC) was 62%.

When compared with sarcopenia (as determined by calf circumference, grip strength, and physical performance), SARC-F as a screening tool had 51% sensitivity, 60% specificity, 67.6% positive predictive value, and 42.9% negative predictive value. SARC-CalF, in contrast, had a higher sensitivity of 79.6%, a higher specificity of 96.7%, a positive predictive value of 95.1%, and a negative predictive value of 74.4% (Table 3).

3.3. Outcomes during hospitalization and 28 days post-discharge

Of the six participants who developed hospital-acquired infections, four had sarcopenia (CC) (p = 0.768). Two participants were transferred to critical care; both had sarcopenia (CC) (p = 0.252). Three participants passed away during hospitalization; all three had sarcopenia (CC) (p = 0.158).

Within 28 days of discharge, one of the participants with sarcopenia (CC) passed away, while none of those without sarcopenia died (p = 0.421). Readmission to the hospital occurred in four (13.8%) participants who did not have sarcopenia and six (12%) of those with sarcopenia within 28 days of discharge (p = 0.942) (Table 4).

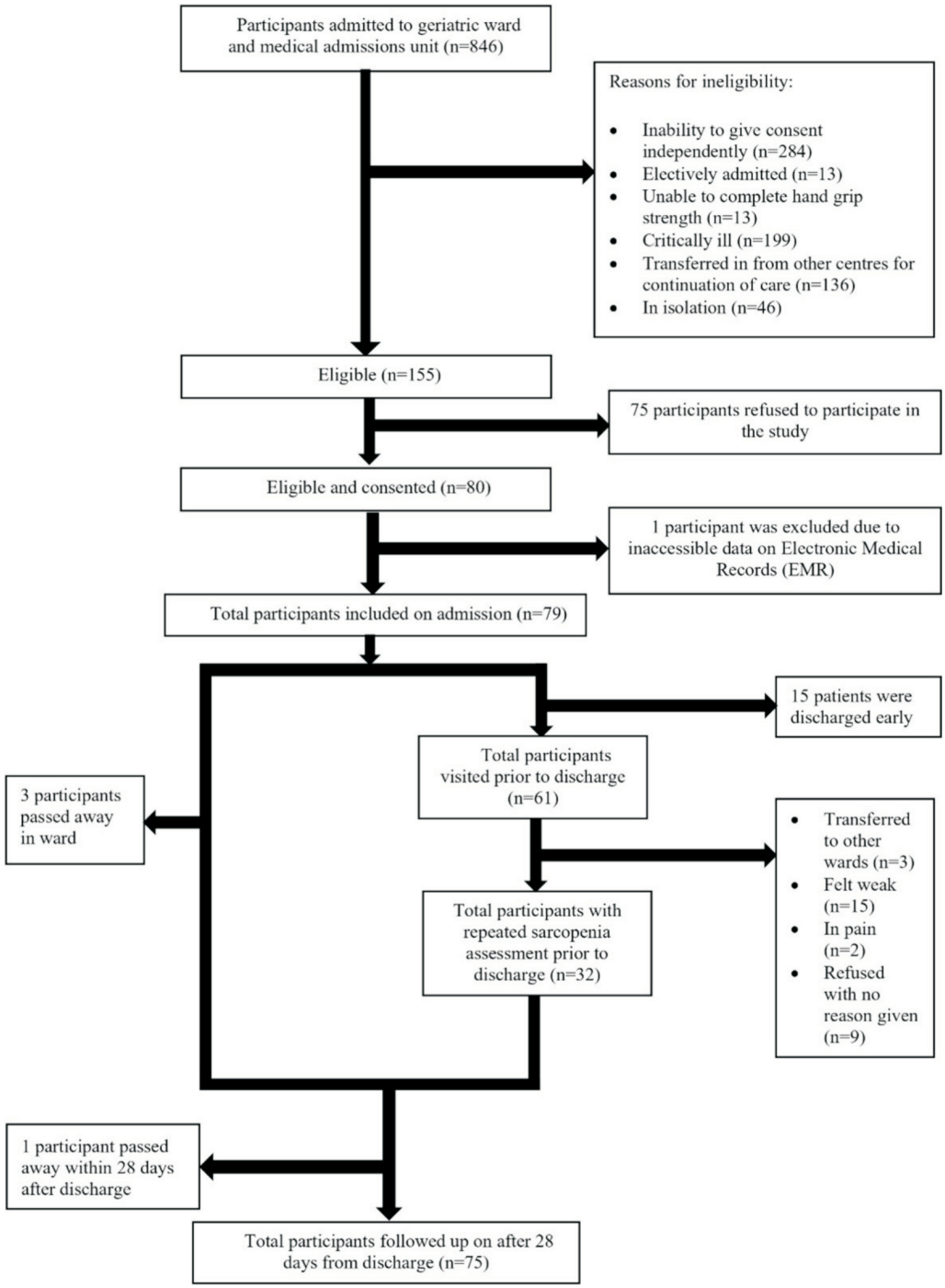

Figure 1. Flowchart of participant recruitment.

4. Discussion

This study reported that the prevalence of sarcopenia using calf circumference, muscle strength, and physical performance among older people admitted to a hospital in Malaysia was 62%. When ASMI was used to confirm sarcopenia as per AWGS criteria, the prevalence was 66.7% using DXA; and 41.2% when BIA was used. By contrast, a meta-analysis reported a 19.8% prevalence of acute sarcopenia among hospitalized elderly patients.[16] In China, when calf circumference was used as a surrogate for muscle mass, the prevalence of possible sarcopenia among older people admitted to hospital was 31%.[4] However, different equipment, assessment thresholds and patient cohorts were used in these studies. Despite many international recommendations, not all may be suited to acute care settings with different access to muscle assessment facilities.

This study reported low uptake of DXA and BIA (9.5% completed DXA and 21.5% completed BIA), reflecting the challenges faced in the acute care setting. DXA had the lowest completion rate, followed by the 5-time chair stand test (19% completed), BIA, and ultrasonography (51.9% completed, despite being optional). For DXA, limitations included limited slots for inpatient DXA, restrictions imposed by the imaging department during the pandemic, waiting time, availability of imaging technicians and patients' conditions; which had been similarly reported elsewhere.[17,18] To address these factors, future studies should extend recruitment periods to allow for more patients to be scheduled for DXA scans, and involve multi-

Table 1
Participant demographics.

	Total participants, n = 79	Sarcopenia (CC)[a], n = 49	No sarcopenia, n = 30	p-value
Age, median (IQR), years	76 (11)	76 (11)	76 (13)	0.460
Gender				0.436
Male, n (%)	30 (40)	19 (38.8)	11 (36.7)	
Female, n (%)	49 (62)	30 (61.2)	19 (63.3)	
Ethnicity				0.876
Chinese, n (%)	25 (31.6)	16 (32.7)	9 (30)	
Malay, n (%)	34 (43)	20 (40.8)	14 (46.7)	
Indian, n (%)	20 (25.3)	13 (26.5)	7 (23.3)	
Frailty[b]				0.786
Scores 1–3, n (%)	13 (16.5)	7 (14.3)	6 (20)	
Scores 4–6, n (%)	57 (72.2)	36 (73.4)	21 (70)	
Scores 7–9, n (%)	9 (11.4)	6 (12.2)	3 (10)	
Comorbidities				
Multimorbidity[c], n (%)	64 (81)	40 (81.6)	24 (80)	0.857
Diabetes mellitus, n (%)	51 (64.6)	32 (65.3)	19 (63.3)	0.859
Hypertension, n (%)	62 (78.5)	38 (77.6)	24 (80)	0.797
Dyslipidaemia, n (%)	25 (31.6)	13 (26.5)	12 (40)	0.212
Ischaemic heart disease, n (%)	13 (16.5)	11 (22.4)	2 (6.7)	0.066
Chronic kidney disease, n (%)	19 (24.1)	12 (24.5)	7 (23.3)	0.907
Chronic liver disease, n (%)	1 (1.3)	1 (2)	0 (0)	0.431
Osteoporosis, n (%)	5 (6.3)	2 (4.1)	3 (10)	0.294
Parkinson's disease, n (%)	1 (1.3)	1 (2)	0 (0)	
Malignancies, n (%)	14 (17.7)	10 (20.4)	4 (13.3)	0.424
Charlson comorbidity index (CCI)[d]				0.078
Mild, n (%)	3 (3.8)	0 (0)	3 (10)	
Moderate, n (%)	23 (29.1)	15 (30.6)	8 (26.7)	
Severe, n (%)	53 (67.1)	34 (69.4)	19 (63.3)	
Falls in the past 12 months, n (%)	24 (30.4)	17 (34.7)	7 (23.3)	0.287
Cognitive impairment[e], n (%)	60 (75.9)	37 (75.5)	23 (76.7)	0.907
Polypharmacy[f], n (%)	52 (65.8)	34	18	0.393
Body mass index (kg/m^2), Median (IQR)	24.3 (5.2)	22.9 (3.5)	26.9 (7.1)	< 0.001*
Risk for malnutrition[g]				0.743
Low risk, n (%)	47 (59.5)	28 (57.1)	19 (63.3)	
Medium risk, n (%)	6 (7.6)	5 (10.2)	1 (3.3)	
High risk, n (%)	26 (32.9)	16 (32.7)	10 (33.3)	
Delirium[h], n (%)	28 (35.4)	18 (36.7)	10 (33.3)	0.971

* Correlation is significant at the 0.01 level (2-tailed).
Abbreviations: IQR, Interquartile range.
[a] Sarcopenia (CC) refers to low calf circumference and either low hand grip strength or a prolonged 5-time chair stand test. [b] Frailty was determined using the Clinical Frailty Scale (CFS). [c] Multimorbidity, or multiple morbidity, refers to having the combination of three or more: diabetes, asthma, arthritis, chronic obstructive pulmonary disease, heart disease, Alzheimer's disease and related dementias, mental disorder (mood disorder and/or anxiety), cancer, and stroke (14). [d] Based on the Charlson Comorbidity Index score, the severity of morbidity was defined as such: scores 1–2 = mild, scores 3–4 = moderate, and scores 5 and above = severe. [e] Cognitive impairment refers to scores of less than 26 on the Montreal Cognitive Assessment Test (MoCA). [f] Polypharmacy refers to being on more than 4 medications (15). [g] Risk for malnutrition refers to scores on the Malnutrition Universal Screening Tool (MUST). [h] Delirium: scores 4 and above on My4AT.

Table 2
Completion rates for respective sarcopenia assessment components.

Sarcopenia assessment components	Measures	Completion rate, n (%)
Sarcopenia screening	SARC-F	79 (100)
	SARC-CalF	79 (100)
Muscle mass	Calf circumference	79 (100)
	ASMI (BIA)	17 (21.5)
	ASMI (DXA)	12 (9.5)
Muscle strength	Hand grip strength assessment	79 (100)
Physical performance	5-time chair stand test	24 (19)

Abbreviations: ASMI, appendicular skeletal muscle index; BIA, bioelectrical Impedance analysis; DXA, dual X-ray absorptiometry.

center collaboration to reduce reliance on a single facility. The 5-stand chair test, which was an important component of assessing physical performance, had low completion rate in this study (19%) due to participants' perceived weakness (n = 46 who refused) and instability (n = 4 who refused), therefore other methods better suited to patients in the acute care setting, such as the point-based Short Physical Performance Battery tests; or 6-meter walk tests;[13] should be considered. Portable BIA devices can also be used in supine position for patients with mobility issues.

Alternatively, screening tools like the SARC-F and SARC-CalF, which were completed by all participants in this study, could be used in the acute care setting as per AWGS recommendation.[13] SARC-CalF

Table 3
Sensitivity, specificity, positive and negative predictive values of respective sarcopenia screening.

Screening tool	Sarcopenia definition		Total
	Sarcopenia (CC)[a]	No sarcopenia	
SARC-F[b]			
Normal, n (% within sarcopenia (CC))	24 (49)	18 (60)	42 (53.2)
At risk, n (% within sarcopenia (CC))	25 (51)	12 (40)	37 (46.8)
SARC-CalF[c]			
Normal, n (% within sarcopenia (CC))	10 (20.4)	29 (96.7)	39 (49.4)
At risk, n (% within sarcopenia (CC))	39 (79.6)	1 (3.3)	40 (50.6)

	Sensitivity	Specificity	Positive predictive value	Negative predictive value
SARC-F	51%	60%	67.6%	42.9%
SARC-CalF	79.6%	96.7%	95.1%	74.4%

[a] Sarcopenia (CC) refers to low calf circumference and either low hand grip strength or a prolonged 5-time chair stand test (13). [b] SARC-F scores 4 or more = at risk for sarcopenia. [c] SARC-CalF scores 11 or more = at risk for sarcopenia.

Table 4
Clinical outcomes according to sarcopenia (CC) diagnosis.

	Sarcopenia (CC), n = 49	No sarcopenia, n = 30	p-value
Days in hospital, median (IQR)	10 (13)	7 (7.3)	0.270
Developed hospital-acquired infections, n (%)	4 (8.2)	2 (6.7)	0.768
Transferred to critical care unit, n (%)	2 (4.1)	0 (0)	0.252
Death in hospital, n (%)	3 (6.1)	0 (0)	0.158
Readmitted within 28 days of discharge, n (%)	6 (12.2)	4 (13.3)	0.421
Death within 28 days of discharge, n (%)	1 (2)	0 (0)	0.942
MBI on admission			0.915
Min-mild dependency, n (%)	34 (69.4)	23 (76.7)	
Moderate dependency, n (%)	9 (18.4)	5 (16.7)	
Severe – total dependency, n (%)	6 (12.2)	2 (6.7)	
MBI upon discharge			0.985
Min-mild dependency, n (%)	24 (49)	16 (53.3)	
Moderate dependency, n (%)	12 (24.5)	10 (33.3)	
Severe – total dependency, n (%)	7 (14.3)	4 (13.3)	

Abbreviations: MBI, Modified Barthel Index.

and SARC-F as screening tools detected 50.6% and 46.8% of the participants being at risk for sarcopenia. SARC-CalF showed good sensitivity (79.6%), specificity (96.7%), positive predictive value (95.1%), and negative predictive value (74.4%). However, both these tools had small to medium effect sizes (SARC-F Cohen's h = 0.246, SARC-CalF Cohen's h = 0.23), which can be improved in future studies by increasing the sample size of the participants.

Existing research had consistently shown that sarcopenia is associated with adverse health outcomes among older adults such as readmission rates and mortality, particularly in hospitalized populations.[19,20] In comparison to these studies, the present study had a smaller sample size, which may have limited the statistical power to detect significant associations. Additionally, the low event rates for outcomes such as death and readmission in this study's sample might have contributed to the lack of significant findings. Among variables evaluated in this observational study, only BMI was significantly associated with sarcopenia (CC), reaffirming Hao et al.'s observation that a higher BMI was a protective factor against sarcopenia (OR: 0.75, 95% CI: 0.68–0.83).[4]

This study was not able to elicit any significant association between hospital sarcopenia and other risk factors or health outcomes due to the small sample size and small event rate. This study also did not adjust for potential confounders such as age, BMI, nutritional status, conditions during hospital admission, and comorbidities, which may have influenced the relationship between sarcopenia and clinical outcomes. As a result, the non-significant findings must be interpreted with caution.

One of the strengths of this study was that it adhered to the internationally recognized AWGS criteria for sarcopenia definition, which encompassed measures of muscle mass, muscle strength, and physical performance. This study also attempted to examine the acute muscle changes during hospitalization targeting older people for whom early screening and intervention are crucial. This study also provided a first-hand account of conducting research involving older people in the acute care setting and its challenges.

Other than that, this study highlighted the importance of research on sarcopenia in hospitals, given its high prevalence (62%), thus it should be part of routine assessment. Internationally established sarcopenia definitions such as the sarcopenia definition and outcomes consortium (SDOC) and the Australian and New Zealand Society for Sarcopenia and Frailty Research ANZSSFR Expert Working Group have moved away from defining sarcopenia around low muscle mass, as they prioritise assessment of muscle strength.[9,10] This study's findings support these recommendations, advocating for at least one assessment of muscle strength during hospital admission to detect probable sarcopenia. Combining this with calf circumference might be a feasible approach to determining sarcopenia in acute care settings that have limited access to BIA and DXA, per AWGS recommendation.[13] Where possible, combining them with gait speed tests have been reported to improve sensitivity and specificity in detecting sarcopenia.[21]

5. Conclusion

In conclusion, this study reported on the prevalence and diagnostic challenges of sarcopenia among older individuals admitted to

hospitals in acute care settings. The use of calf circumference as a surrogate measure revealed a high prevalence of sarcopenia in this population. However, the low uptake of these diagnostic modalities highlighted the practical challenges within acute care settings. Further studies in this area should address the existing limitations, such as the small sample size and the brief participant stay.

Acknowledgements

This study was supported by the Universiti Malaya Faculty of Medicine Research Programme Grant (GPF007-2020). Dr Wan Safiyyah Nurnajah was a recipient of the Universiti Malaya Faculty of Medicine's Postgraduate Scholarship Fund.

References

1. Welch C, Hassan-Smith ZK, Greig CA, Lord JM, Jackson TA. Acute sarcopenia secondary to hospitalization - an emerging condition affecting older adults. *Aging Dis*. 2018;9(1):151–164. doi:10.14336/AD.2017.0315
2. Zhao Y, Zhang Y, Hao Q, Ge M, Dong B. Sarcopenia and hospital-related outcomes in the old people: a systematic review and meta-analysis. *Aging Clin Exp Res.* 2019;31(1):5–14. doi:10.1007/s40520-018-0931-z
3. Vetrano DL, Landi F, Volpato S, et al. Association of sarcopenia with short- and long-term mortality in older adults admitted to acute care wards: results from the CRIME study. *J Gerontol A Biol Sci Med Sci*. 2014;69(9): 1154–11561. doi:10.1093/gerona/glu034
4. Hao Q, Hu X, Xie L, et al. Prevalence of sarcopenia and associated factors in hospitalized older patients: A cross-sectional study. *Australas J Ageing*. 2018;37(1):62–67. doi:10.1111/ajag.12492
5. Maeda K, Akagi J. Sarcopenia is an independent risk factor of dysphagia in hospitalized older people. *Geriatr Gerontol Int*. 2016;16(4):515–521. doi:10.1111/ggi.12486
6. Heo WS, Baik HW, Kang JH, et al. The prevalence of sarcopenia in Korean hospitalized elderly. *Ann Geriatr Med Res*. 2015;19(4):235–240. doi:10.4235/jkgs.2015.19.4.235
7. Van Nguyen T, Tran KD, Bui KX, Le D, Nguyen TN. A preliminary study to identify the likely risk for sarcopenia in older hospitalized patients with cardiovascular disease in Vietnam. *Australas J Ageing*. 2020;39(3):e315–e321. doi:10.1111/ajag.12789
8. Alhmly HF, Fielding RA. A critical review of current worldwide definitions of sarcopenia. *Calcif Tissue Int*. 2024;114(1):74–81. doi:10.1007/s00223-023-01163-3
9. Bhasin S, Travison TG, Manini TM, et al. Sarcopenia definition: the position statements of the sarcopenia definition and outcomes consortium. *J Am Geriatr Soc*. 2020;68(7):1410–1418. doi:10.1111/jgs.16372
10. Daly RM, Iuliano S, Fyfe JJ, et al. Screening, diagnosis and management of sarcopenia and frailty in hospitalized older adults: recommendations from the Australian and New Zealand Society for Sarcopenia and Frailty Research (ANZSSFR) Expert Working Group. *J Nutr Health Aging*. 2022; 26(6):637–651. doi:10.1007/s12603-022-1801-0
11. Connolly K, Cunningham C, Murphy N, Romero-Ortuno R, Horgan F. Prevalence of sarcopenia and associated factors in older adults attending a day hospital service in Ireland. *Eur Geriatr Med*. 2021;12(4):851–862. doi:10.1007/s41999-021-00463-x
12. Rangel Peniche DB, Raya Giorguli G, Alemán-Mateo H. Accuracy of a predictive bioelectrical impedance analysis equation for estimating appendicular skeletal muscle mass in a non-Caucasian sample of older people. *Arch Gerontol Geriatr.* 2015;61(1):39–43. doi:10.1016/j.archger.2015.03.007
13. 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
14. Roberts KC, Rao DP, Bennett TL, Loukine L, Jayaraman GC. Prevalence and patterns of chronic disease multimorbidity and associated determinants in Canada. *Health Promot Chronic Dis Prev Can*. 2015;35(6):87–94. doi: 10.24095/hpcdp.35.6.01
15. Mastromarino V, Casenghi M, Testa M, et al. Polypharmacy in heart failure patients. *Curr Heart Fail Rep*. 2014;11(2):212–219. doi:10.1007/s11897-014-0186-8
16. Gonzales AG, Ramos M. Meta-analysis of acute sarcopenia among hospitalized elderly patients. *J Geriatr Med Gerontol*. 2021;7:126. doi:10.23937/2469-5858/1510126
17. Buckinx F, Landi F, Cesari M, et al. Pitfalls in the measurement of muscle mass: a need for a reference standard. *J Cachexia Sarcopenia Muscle*. 2018;9(2):269–278. doi:10.1002/jcsm.12268
18. Bodilsen AC, Pedersen MM, Petersen J, et al. Acute hospitalization of the older patient: changes in muscle strength and functional performance during hospitalization and 30 days after discharge. *Am J Phys Med Rehabil*. 2013;92(9):789–796. doi:10.1097/PHM.0b013e31828cd2b6
19. Vetrano DL, Landi F, Volpato S, et al. Association of sarcopenia with short- and long-term mortality in older adults admitted to acute care wards: results from the CRIME study. *J Gerontol A Biol Sci Med Sci*. 2014;69(9): 1154–1161. doi:10.1093/gerona/glu034
20. Zhao Y, Zhang Y, Hao Q, Ge M, Dong B. Sarcopenia and hospital-related outcomes in the old people: a systematic review and meta-analysis. *Aging Clin Exp Res*. 2019;31(1):5–14. doi:10.1007/s40520-018-0931-z
21. Rossi AP, Fantin F, Micciolo R, et al. Identifying sarcopenia in acute care setting patients. *J Am Med Dir Assoc*. 2014;15(4):303.e7–303.e12. doi: 10.1016/j.jamda.2013.11.018